GEOLOGICAL SURVEY OF GEORGIA

S. W. McCALLIE, State Geologist

BULLETIN NO. 39

HISTORICAL SKETCH

OF THE

GEOLOGICAL SURVEY

OF

GEORGIA

BIBLIOGRAPHY AND OTHER DATA

BY

H. S. CAVE

Assistant State Geologist

VIEW SHOWING A PART OF THE STATE MUSEUM, THIRD FLOOR, STATE CAPITOL BUILDING.

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1922
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ATLANTA, GA.

THE ADVISORY BOARD

OF THE

Geological Survey of Georgia

IN THE YEAR 1922

(Ex-Officio)

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LETTER OF TRANSMITTAL

GEOLOGICAL SURVEY OF GEORGIA,

ATLANTA, June 1, 1922.

To His Excellency, THOS. W. HARDWICK, *Governor, and President of the Advisory Board of the Geological Survey of Georgia.*

SIR: I have the honor to transmit herewith the report of Mr. H. S. Cave, Assistant State Geologist, a Historical Sketch of the Geological Survey of Georgia, Bibliography, and Other Data, to be published as Bulletin No 39 of this Survey.

Very respectfully,

S. W. MCCALLIE,
State Geologist.

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INTRODUCTORY

In the following pages is given a brief history of the Geological Survey of Georgia, together with a bibliography of the geology, mineralogy, and paleontology of the State and other data.

The historical sketch of the Survey includes its organization, personnel and publications. Likewise a short historical sketch of the State museum, together with a short description of the present museum, is also set forth.

A considerable portion of the bulletin is of a statistical nature, being devoted to brief notes on the various mineral products of Georgia with statistics of production, and lists of the active mineral producers in the State.

PHYSIOGRAPHICAL DIVISIONS OF GEORGIA

In order that the physiographical divisions of the State as used in this report may be better understood, a brief description of each is here given.

Following the classification used by Veatch and Stephenson in the report on the Geology of the Coastal Plain of Georgia, the subdivisions are, beginning in the northwest: (1) Cumberland Plateau; (2) Appalachian Valley; (3) Appalachian Mountains; (4) Piedmont Plateau; (5) Coastal Plain.

Cumberland Plateau.—The Cumberland Plateau is made up of flat-topped mountains or tablelands and occupies a small area in Dade and Walker counties. The general elevation is 1,500 to 2,300 feet above sea level. The topography is of the dissected upland type.

Appalachian Valley.—The Appalachian Valley lies between the Cumberland Plateau on the west and the Appalachian Mountains on the east. In general, it is a valley within which are a number of

parallel ridges. The valley is 40 to 50 miles wide and extends from the Tennessee line to the southern part of Polk county and across the State into Alabama. The ridges are steep-sided, due to the resistance of the harder strata to erosion. The valleys have elevations of from 600 to 900 feet above sea level and the ridges 1,000 and 1,800 feet.

Appalachian Mountains.—The Appalachian Mountain area is composed mainly of the Blue Ridge, with lesser groups to the east and west. The area occupies the northeastern portion of the State. The topography is rugged, with a complexity of topographic forms. The maximum elevation is about 5,000 feet above sea level.

Piedmont Plateau.—The Piedmont Plateau lies between the Appalachian Mountains and the Coastal Plain. It is a southward sloping plain ranging in elevation from 1,200 to 300-400 feet above sea level. The topography is a gently rolling type with very few sharp breaks, presenting on the whole an even skyline.

Coastal Plain.—The Coastal Plain includes that portion of the State lying south of the Piedmont Plateau. The contact between these two divisions is known as the Fall Line, a somewhat indefinite line extending from Augusta, through Milledgeville and Macon to Columbus. The Fall Line derives its name from the falls or rapids on the streams at the places where they flow from the Piedmont crystalline rocks to the softer and less resistant rocks of the Coastal Plain.

In general the Coastal Plain is a low plain having a gentle southward inclination. Topographically it is a region of low relief, the slopes being gentle and the hills never rising above a general level. The plain reaches a maximum elevation of 650-700 feet above sea level between Macon and Columbus. More than half of it has an elevation of less than 300 feet, while nearly one-seventh of the whole is less than 100 feet above the sea level.

HISTORICAL SKETCH OF GEOLOGICAL SURVEY OF GEORGIA

EARLY GEOLOGICAL WORK IN GEORGIA

The history of the Geological Survey of Georgia should logically be preceded by a somewhat brief account of earlier geological work done in the State, together with a statement of the conditions influencing the establishment of the earliest State Geological Surveys of the United States.

The earliest observations on the geology of Georgia, of which we have record, are those of William Bartram which appeared in his "Travels through North and South Carolina, Georgia, East and West Florida," published in 1792. These observations are more strictly of a physiographical, rather than of a geological nature and were made on his travels through the Carolinas, Georgia, and Florida in 1773.

The publication gives a general description of the banks of the Altamaha and Oconee rivers together with a detailed description of some of the high bluffs.

In his trip up the Savannah River, he gives the first general outlining of the physiographical division of Georgia, which is here quoted. [1]"In our progress from the seacoast, we rise gradually, by several steps or ascents in the following manner: first, from the seacoast, fifty miles back is a level plain, generally of a loose sandy soil, producing spacious high forests . . . ., nearly one-third of this vast plain is what the inhabitants call swamps, which are the sources of numerous small rivers and their branches. . . . . The upper surface of these swamps is a perfectly black, soapy, rich earth, or stiff mud, two or three feet deep on a foundation or stratum of calcareous fossil which the inhabitants call white marl.

"We now rise a bank of considerable height, which runs nearly parallel to the coast, through Carolina and Georgia; the ascent is gradual by several flights or stages for eight or ten miles, the perpendicular height whereof, above the level of the ocean, may be two or three hundred feet (and those are called the sand hills), when we find ourselves on the entrance of a vast plain, generally level, which extends west 60 or 70 miles, rising gently as the former, but more perceptibly. This plain is mostly a forest of the great long-leaved pine.

"The earth under this level plain may be described after the following manner: the upper surface, or vegetative mould, is a light sandy loam, generally nine inches or a foot deep, on a stratum of ci-

[1]Bartram, William, "Travels through North and South Carolinas, Georgia, East and West Florida," 1792.

nereous clay. Stone of any sort, or gravel, is seldom seen. The next ascent, or flight, is of much greater and more abrupt elevation, and continues rising by broken ridges, and narrow levels, or vales, for ten or fifteen miles. When we rest again on another extensive, nearly level, plain of pine forests—which continue west forty or fifty miles. The soil is of a dusky brown colour, lying on a stratum of reddish brown tough clay."

From Augusta Bartram visited what he termed the great Buffalo Lick, which he describes as follows: "This extraordinary place (the Buffalo Lick) occupies several acres of ground at the foot of the Great Ridge which divides the Savannah and the Altamaha; South-east of it is a cane swamp from which the great Ogeechee river rises. The place called the Lick contains three or four acres, is nearly level, and lies between the head of the cane swamp and the ascent of the Ridge. The earth, from the superficies to an unknown depth, is an almost white or cinereous coloured tenacious fattish clay."

The natives believed the clay of the Lick to be impregnated with saline vapours but Bartram noted nothing saline to the taste, there being only an insipid sweetness. The exact location of this Lick is at present unknown.

The region north and west of Broad River Bartram terms the middle region. This he describes as follows: "The rocks and fossils which constitute the hills of this middle region are of varying species, as quartsum, ferrum, cos, silex, glarea, arena, ochra, stalactites, saxum, mica, etc. I saw no sign of marble, plaster, or limestone; yet there are, near Augusta, in the forests, great piles of a porous, friable white rock, in large and nearly horizontal masses, which seem to be an heterogenous concrete, consisting of pulverized sea shells, with a small proportion of sand."

Between the time of publication of Bartram's Travels in 1792 and the year 1836 there were published a number of articles pertaining to the geology of Georgia. Of these the following were directly on Georgia Geology: "Novaculite in Georgia," by J. C. Kenney, published in 1829, "Essay on the Georgia Gold Mines," by W. Phillips, published in 1833, "Geological and Mineralogical Account of the Mining Districts of Georgia," by Jacob Peck, published in 1833, and "Geological Observations Upon Alabama, Georgia, and Florida," by C. U. Shepard, published in 1834.

The visits of Sir Charles Lyell to Georgia, though following the establishment of the State Geological Survey, may be here mentioned as a portion of the earliest geological work done in Georgia and as perhaps the first real paleontological work. On his first trip to America Lyell visited Georgia late in December 1841 and early in

1842. Among the places described by him were Shell Bluff, Stoney Bluff, and Hudson's Reach, all on the Savannah River. In 1842 he collected some mastodon and mylodon bones from a six-foot bed of red clay on White Bluff Creek, 12 miles from Savannah.

Writing concerning Shell Bluff he gives only the following brief description. [1]"I landed first at a cliff about 120 feet high, called Shell Bluff, from the large fossil oysters which are conspicuous there. . . . . I fossilized for three days very diligently at Shell Bluff, obtaining more than forty species of shells, chiefly casts, referable to the Eocene formation."

Writing on Stoney Bluff he gives the following, [2]"I began by exercising my hammer on the burr-stone of this low bluff; a cellular kind of flint, sometimes used for millstones, and full of silicified corals, and minute shells, and, as I afterwards found, by aid of a powerful microscope, of sponges. It is an Eocene formation, and alternates with beds of red loam."

Of Hudson's Beach he gives the following note, [3]"At Hudson's Reach and other points I found Eocene shells and fishes teeth, chiefly of the genera myliobates and Lamma."

EARLY STATE GEOLOGICAL SURVEYS OF THE UNITED STATES

Turning from the early geological work in Georgia, it will be in order to briefly consider what was perhaps the most impelling cause of the beginnings of our State Geological Surveys in the United States.

The closing quarter of the eighteenth century and the first quarter of the nineteenth century marked the beginning of the modern school of geological thought. This period saw the gradual decay of Wernerism and marked the beginning of modern stratigraphy, stratigraphic paleontology and petrography. This period brought forth such men as Von Buch, Hutton, James Hall, Giraud-Soulavie, Cuvier, Brongniart, William Smith, Murchison, Sedgwick, Nicol and Sorby; those being closely followed by Logan, Agassiz, Lyell, and Charles Darwin. Especially the work of Hutton, Giraud-Soulavie, Cuvier, Brongniart, and William Smith changed the existing thought and methods of geology.

The writings of the above mentioned men greatly stimulated the public interest in geology as a science and we see its reflection in the public mind of the United States in the establishment of our State Geological Surveys. North Carolina took the lead, the year

[1]Lyell, Sir Chas. Travels in North America, Vol. 1, pp. 156 and 158.
[2]pp. 158-159 Ibid.
[3]pp. 161-162 Ibid.

1823 marking the beginning of her State Geological Survey. South Carolina followed her example in 1826. The most active beginnings were in the years 1835, 1836, and 1838. By the year 1845 there had been started the State Geological Surveys of Connecticut, Maryland, Georgia, Maine, Michigan, New Jersey, New York, Ohio, Pennsylvania, Rhode Island, Tennessee, Virginia, and Wisconsin.

BEGINNINGS OF THE GEOLOGICAL SURVEY OF GEORGIA

The first actual geological survey of any portion of Georgia was made by John R. Cotting in the summer of 1836. This was a geological and agricultural examination of Burke and Richmond counties. Perhaps its chief significance lies in the fact that the work was authorized and paid for by the citizens of the said two counties. The published report was a volume of 189 pages, under the date of 1836. It was devoted chiefly to the economic geology of the Crystalline and Tertiary formations of Burke and Richmond counties. It later formed a part of the annual report of John R. Cotting, as State Geologist, in 1837.

At approximately the same time the first really effective attempt to establish a geological survey of Georgia was made by Governor Schley in his message to the general assembly in 1836. In discussing the internal improvement of the State the Governor wrote as follows:

"Intimately connected with this subject is that of the geological structure of the State and its mineral resources. A proper knowledge of these is necessary to a prudent and profitable location of canals and railroads and should have its influence in directing their course. Thus far, Georgia has scarcely looked beneath her surface, and her great staple commodity has been the only article of transportation within the contemplation of those who have projected schemes of internal improvement, whilst the advantage to be derived from geological investigation has been entirely overlooked. In such a survey the whole State is interested, not merely in the increased variety of its products, but in the promotion of the most efficient culture by disclosing the character and capacity of the soil. Her territory, particularly that part comprehended within the Cherokee circuit, is believed to abound in mines of gold, marble, iron, limestone, salt, and other valuable minerals. These concealed treasures, which should be made tributary to her knowledge and wealth, are worthy of your enlightened consideration, and the provision necessary to a full and scientific examination of them ought not to be longer delayed. I suggest, therefore, the propriety of employing a competent geologist

to make a thorough survey of the State, with a view to the ascertainment of its mineral and agricultural resources and the proper location of works of internal improvement."

Governor Schley supplemented the foregoing recommendation by the following note: "Since the above was written, I have received from Mr. John R. Cotting a letter dated at Augusta on the 15th ultimo, accompanied by a report of a geological and agricultural examination made by him, during the past summer, of the counties of Burke and Richmond. This survey was executed at the expense of individuals of these counties and is highly creditable to their public spirit and, as far as I can judge, equally so to the skill and capacity of Mr. Cotting as a scientific and practical geologist. I avail myself with pleasure of the opportunity thus afforded me of sending to the house of representatives this letter and report, with the hope that they may add force to the recommendation I have submitted."

As a result of the governor's recommendation, the legislature appointed a committee to consider the advisability of establishing a Geological Survey. On November 26, 1836, this committee made the following report to the general assembly: "Resolved, That his excellency, the governor, be, and is hereby authorized to employ as soon as practical one or more suitable and qualified persons to undertake the work of a careful and scientific survey of all the counties in this State, under his instructions and advice.

"Be it further resolved, That the sum of $10,000 be appropriated for that purpose, subject to the warrant of the executive out of any moneys in the treasury, not otherwise appropriated, and the same to be inserted in the appropriation act of this session of the general assembly."

THE ADMINISTRATION OF DR. JOHN R. COTTING

The above resolution being favorably acted upon by the general assembly the governor subsequently appointed Dr. John R. Cotting State Geologist. Cotting submitted his first annual report to the general assembly in 1837. This report covered, in some detail, the counties of Burke, Chatham, Columbia, Effingham, Elbert, Franklin, Habersham, Lincoln, and Richmond, and parts of Oglethorpe and Wilkes. It was referred to a special committee which apparently reviewed it with considerable interest, as the said committee pointed out the important work done in locating valuable deposits of marl and graphite, and in establishing the magnetic variations at twenty different points in the counties in which the work had been done. The committee recommended that the report of the State Geologist

be published and that copies of the tables of magnetic variation be sent to the clerks of the inferior courts of the several counties surveyed, in order that they might there be preserved for the benefit of county surveyors and all other persons interested. The resolution of the committee was passed by the general assembly but got no farther for the reasons given in the following extract from the house journal for 1838: "The resolution passed at your last session directing the publication of the annual report of Dr. Cotting's Geological Survey was not presented for approval until after the time had expired within which, by the constitution, the governor is authorized to sign resolutions. This circumstance together with some difficulties which occurred between Dr. Cotting and the State Printer, as to the time and manner of printing, has prevented the publication of the report. This is, perhaps, not to be regretted, as it appears to be the intention of the Legislature to publish a full report when the entire survey shall be completed.

"The Legislature is referred to the correspondence with the State Geologist and State Printer, for further explanation on this subject.

"The accompanying report of Dr. Cotting shows what have been his operations during the past year."

The nature of the report of Dr. Cotting, above referred to, is not known as no other data pertaining to it is available and there is no record to show that it was ever published.

Abolition of the Cotting Survey.—In 1839 there was a resolution introduced in the house to abolish the Geological Survey on the grounds that it had spent the whole of the $10,000 appropriation to carry on the work without benefit to the citizens of the State.

The House passed the resolution but the Senate did not concur. The resolution was again introduced in 1840, and passing in both Houses, the office of State Geologist was abolished November 6, 1840.

Re-establishment of the Survey.—In 1845 there was introduced in the house a resolution relative to the geological survey of Georgia. The resolution was read but no action was taken on it. The house journal does not show what was the nature of this resolution.

Resolutions to create the office of State Geologist and to provide for a geological survey of the State were introduced without success in the years 1850, 1857, 1860, 1868 and 1869.

In the year 1873 the resolution to revive the office of State Geologist was passed by the House but either it was not passed by the Senate or was not approved by the governor for the same resolution was again introduced, passed, and was approved on Feb. 27, 1874. This act was amended Feb. 27, 1875, for the purpose of fixing the place where work was to be commenced.

THE ADMINISTRATION OF DR. GEORGE LITTLE

The act provided for the annual appropriation of $10,000 for a period of five years for the purpose of making a "geological, mineralogical, and physical survey" of the State. In August, 1874, the governor appointed Dr. George Little, State Geologist. During Dr. Little's term of office he made two annual reports of progress; the first of 30 pages covering the period from September 1 to December 31, 1874, and the second of 16 pages for the year 1875, published in 1876. There was also published in 1876 in the Georgia Department of Agriculture a Hand-Book containing an article of 126 pages and one map treating of the geology, mineralogy, climate, soils, and water powers of the State. These publications, together with a 16 page catalogue of ores, rocks, and woods selected for the Paris exposition, are apparently the only ones issued by the Survey under Dr. Little's administration.

Discontinuance of the Survey.—As funds were provided for five years only by the Act of 1874, the geological survey was interrupted after the year 1879. In 1878 and 1879 several bills were introduced providing for the continuance thereof but failed of passage. In 1885 the effort to re-establish the department was renewed but without result.

During the period 1879 to 1889 the only State Geological work done was done by the State Department of Agriculture. The results of this work was published in the volume, "Commonwealth of Georgia," under the date of 1885. There was, however, geological work done by persons not connected with the State.

THE PRESENT GEOLOGICAL SURVEY

The present Survey had its beginning in 1889, when, on November 23 of that year, there was passed "a bill to revive the office of State Geologist, and to provide for a geological, mineralogical, and physical survey of the State of Georgia, etc."

BILL UNDER WHICH THE PRESENT SURVEY OPERATES

State Geologist.—The governor shall appoint, with the consent of the advisory board, a competent person as State Geologist; who shall have a thorough, scientific, and practical knowledge of the science of geology and mineralogy, and who is not connected with any school or college as an instructor. The State Geologist shall enter upon the duties of his office on the first of July, 1890, and shall hold until removed by the appointing power for inefficiency, incompetency, or misconduct, or until the office is abolished by the general assembly. The office of the State Geologist shall be at the seat of government.

Advisory Board.—There shall be an advisory board, consisting of the governor of the State (who shall be president of the board), the commissioner of agriculture, the State school commissioner, the State treasurer, the comptroller-general, the secretary of State, and the attorney-general. Four members present at any meeting shall constitute a quorum for the transaction of any business.

Duty of Geologist.—It shall be the duty of the State Geologist to give his attention to the administration of the survey; to visit all parts of the State, so as to make himself familiar with the needs of each section; to supervise the work of his assistants, including all reports submitted by them for publication; to undertake such field work as his time will permit, and to perform such other duties as properly pertain to his office.

Assistant State Geologists.—Two competent assistant State Geologists shall be chosen by the State Geologist, who shall remove them at any time for incompetency, inefficiency, or misconduct. So soon as a general outline of a geological survey of the entire State shall have been made, the State Geologist shall divide up the work between himself and his assistants in such way as shall be to the State's best interest, and under his direction and control the corps shall proceed to make a careful and complete geological, mineralogical, and physical survey of the State; to enter upon record, to be kept for that purpose in his office, an accurate statement of the extent of all water-powers, roads, springs, and water courses, and the climate, topography, and the general physical character of the country, and to locate the belts of ores, useful minerals, and building materials; to report characteristics and composition of soils and the deposits of marls and phosphates; to collect, analyze, and classify specimens of minerals, rocks, ores, fossils, and soils, and enter

the same on record; to cause to be preserved in a museum specimens illustrating the geology, mineralogy, soils, and whatever else may be discovered in the mineral or geological resources of Georgia, having scientific or economic value; and he shall make a report of the survey of every county of this State, accompanied with all necessary maps and illustrations.

Survey of watercourses, lakes, etc.—It shall also be the duty of said State Geologist to make a survey of the water courses, ponds, lakes, and swamp regions of Georgia, and submit, in the report provided for, a topographical map showing the location, extent, means, and plans of drainage, and also an estimate of the cost of said drainage of the ponds, lakes, and swamps of Georgia. The said State Geologist shall also make an estimate of the value and extent of the lands to be reclaimed by said drainage.

Employment of topographers and drivers.—The State Geologist is hereby authorized to employ two competent topographers and four assistant topographers and two drivers, as may be necessary to carry out the purpose of this chapter.

State Geologist to supervise.—The State Geologist shall have supervision of the entire work of the survey, and shall be responsible for the accuracy of the same. It shall be the duty of the State Geologist to make a report to the advisory board once in every three months—to wit, on the second Wednesdays in March, June, September, and December of each year.

No special surveys.—No individual, firm, or corporation shall have the right to call upon or require the State Geologist to enter upon any special survey for his or their special benefit; but the survey is to proceed upon a settled plan for the benefit of the public, and investors and developers in general.

Supervision of expenses by board.—The advisory board shall have the supervision of the money expenditures in the prosecution of the work contemplated. The State Geologist shall make to the advisory board monthly statements under oath, of all incidental expenses necessarily incurred by himself and his assistants, accompanied by proper vouchers, in the discharge of their labors. The board shall audit such accounts, item by item, and approve or reject the same, as in their judgment may be right. When an account is allowed, the governor shall draw his warrant for the amount thereof. The governor, with the advice and consent of the board, may at any time suspend the field-operations.

Office kept where.—The State Geologist shall keep his office in a room to be set aside for that purpose by the governor.

Salaries of geologists and assistants.—The salary of the State Geologist shall be thirty-five hundred dollars per annum, and each assistant shall receive such salary per annum as shall be determined by the advisory board of the geological survey on recommendation of the State Geologist: Provided, that each assistant shall not receive more than two thousand dollars per annum.

Specialist.—The State Geologist, with the consent of the board of advisement, may employ a specialist, or specialists, at any time.

When results of surveys may be published.—Neither the State Geologist, nor his assistants, shall disclose to any person, except to the owner of the land, the result of a survey, until the same is made public by publication of the report by the advisory board.

Maps of surveys State property.—The State Geologist and his assistants shall deposit, in the office of the governor, all maps, surveys, notes, or memoranda of surveys, when the surveys are completed, which are hereby declared to be the property of the State."

THE ADMINISTRATION OF DR. J. W. SPENCER

After the revival of the geological survey in 1889, Dr. J. W. Spencer was appointed State Geologist and entered upon his duties on July 1, 1890. As assistants he had Mr. C. C. Anderson, civil engineer, in charge of the hydrographic work of the survey, and Mr. E. T. Whatley, as assistant Geologist. During Dr. Spencer's incumbency the survey published two reports. The first was an administrative report of 144 pages, bearing date of 1891 and dealing chiefly with the Cretaceous and Tertiary formations of the Coastal Plain. The second was entitled, "The Paleozic Group—Geology of Ten Counties of Northwest Georgia."

The latter report, published in 1894, contained 406 pages and a geological map of northwest Georgia. It was on the geology, mineral and economic resources and soils of northwest Georgia. During Dr. Spencer's term of office he also published the following three articles: "Post Pliocene Continental Subsidence (in America) versus Glacial Dams," in the Geological Society of America Bulletin, Volume 2, pp. 465-476, 1891; "Remarks on Rounded Rock Surfaces Due to Causes Other Than Glacial Erosion. Instances Stone Mountain in Georgia," in the Geological Society of

America Bulletin, Volume 1, p. 175, 1890; "Southern Drift and Its Agricultural Relations." In the Bulletin of the Experiment Station of Georgia, p. 5, 1890.

THE ADMINISTRATION OF PROF. W. S. YEATES

Dr. Spencer resigned in 1893 and was followed by Prof. W. S. Yeates, who was appointed State Geologist in July, 1893, and continued in office until his death, which occurred February 18, 1908.

During Prof. Yeates' administration the personnel of the Survey was as follows: In 1893, Prof. S. W. McCallie and Mr. F. P. King were appointed assistant State Geologists. Prof. McCallie continued his services as Assistant State Geologist until his appointment as State Geologist in 1908, following the death of Prof. Yeates. In April, 1896, Mr. King resigned, to be followed by Dr. George E. Ladd. Dr. Ladd held office until his resignation in April, 1898, when he was succeeded by Dr. Thomas L. Watson. Special topographic work was done by Mr. D. Lee Wardroper, and Mr. B. M. Hall had charge of the work on the water powers of Georgia.

During Prof. Yeates' incumbency there was published by him six administrative reports under the dates of Oct. 23, 1894, Oct. 15, 1896, October 17, 1897, October 15, 1898, October 16, 1899, and October 15, 1900. These reports covered the work and progress of the survey, its personnel and matters relative to the State Museum and exhibits.

The following bulletins of the Georgia Geological Survey were published under Prof. Yeates' administration: *Bulletin No. 1, Marbles of Georgia, by S. W. McCallie, 1894.* This Bulletin contains 87 pages and is illustrated with 16 plates, 14 figures and two maps.

The first five pages give an historical sketch of the development of the marble industry in Pickens county, with production statistics of marble in 1893, by States. The next eight pages deal with the origin of limestone from which marble is produced by metamorphism, together with the varieties of limestone. The next 33 pages describe in detail the marbles of Fannin, Gilmer, Pickens, and Cherokee counties, as to character, extent, workings and geological aspects. The next four pages are devoted to the semi-crystalline marbles of Murray, Whitfield, and Floyd counties, in northwestern Georgia. Of the remainder of the volume four pages are devoted to the marble dressing works of the Kennesaw Marble Company, The Blue Ridge Marble Company, and Geo. B. Sickels

and Co.; two pages to specimens of marble collected; ten pages to the machines and implements used in marble working; two pages to physical tests of the Georgia marbles as determined by a microscopic study; and six pages to crushing and absorption tests. The last five pages give a chemical discussion of the marbles of Georgia, by Dr. W. H. Emerson.

Bulletin No. 1. Marbles of Georgia. Second Edition, Revised and Enlarged, by S. W. McCallie, 1907.—This bulletin contains 126 pages and is illustrated by 52 plates, 3 figures and 2 maps. The arrangement and handling of the material is very similar to that of the first edition as given above, but goes more into detail. There are also added three pages on geography, physiography, and geology, two pages devoted to various styles of finish of marble and four pages devoted to the Serpentine or Verd Antique marble of Cherokee county, Georgia.

Bulletin No. 2. Corundum Deposits of Georgia, by Francis P. King, 1894.—This bulletin contains 133 pages and is illustrated by 6 plates, 12 figures and 1 map.

Chapter I is devoted to the history of corundum, taking up in order the early history, the history of corundum in the eastern hemisphere, and the history of corundum in North America, the latter embracing notes on Canada, Maine, Massachusetts, Connecticut, New York, New Jersey, Maryland, Pennsylvania, Virginia, North Carolina, Georgia, South Carolina, Alabama, Montana, Colorado, and California. There is also given the nomenclature of corundum.

Chapter II treats of the varieties of corundum under the three major divisions of (1) Sapphire, (2) Corundum, and (3) Emery, with their respective subdivisions. A portion of the chapter deals with the physical and chemical properties of corundum.

Chapter III treats of the alterations and associate minerals of corundum under the following headings: Oxides of silica, Hydrous oxides of aluminum; Anhydrous oxides of other metals, Anhydrous silicates, Hydrous silicates, and Phosphates.

Chapter IV deals with the geology of the crystalline belt. A general geological sketch is given concerning the geological history, age, topography, physiography and structure of the area.

Chapter V is on the distribution of corundum in Georgia. It treats of the position and geological relations of the corundum-

bearing formations, the corundum veins, varieties of corundum found, the description of the various Georgia localities and the origin of the Georgia corundum.

Chapter VI deals with economics, being devoted to the history of corundum mining in Georgia, the value of the Georgia deposits, the preparation and manufacture of corundum, statistics, and hints to prospectors.

Chapter VII is a bibliography of American literature on corundum.

Chapter VIII is a supplementary chapter dealing with natural and artificial abrasives.

Bulletin No. 3. A part of the Water-Power of Georgia, by C. C. Anderson, and B. M. Hall, 1896.—This bulletin contains 150 pages and is illustrated with 10 plates, 9 figures and 2 maps.

Chapter I is an introductory chapter.

Chapter II is devoted to the recent increase in the value of water-powers, with an enumeration of the great potential powers of Georgia that are going to waste.

Chapter III deals with the streams and drainage basins of Georgia. It treats of the Tennessee, Mobile, Apalachicola, Altamaha, Ogeechee, Savannah, Ocklocknee, Suwanee, and Satilla and St. Mary's Basins. The major streams and their tributaries and their drainage areas are given, together with the water power locations.

Chapter IV is devoted to the flow of streams. The tables of flow and variation of the gauging stations is given. There are also cross-sections of the principal streams at the gauging stations.

Chapter V gives the railroad elevations as compiled from the records of the engineering departments of the railroads of Georgia.

The last section of the bulletin is an appendix in which additional data relative to the various drainage basins is given.

Bulletin No. 4. A part of the gold deposits of Georgia, by W. S. Yeates, S. W. McCallie, and Francis P. King, 1896.—This bulletin contains 542 pages and is illustrated by 21 plates, 38 figures and 1 map.

Chapter I is on the occurrence and history of gold. There is set forth the early history of gold, its geological range and occurrence, statistics of the gold production of the world for 1895, his-

torical notes on the gold of the various countries of the world, and statistics of the annual coinage from the Dahlonega, Georgia, mint for the years 1838 to 1861 inclusive.

Chapter II is devoted to the enumeration, location, and description of the gold mining properties in White county, together with an historical sketch of the gold industry of the said county.

In like manner, Chapters III-XXII, inclusive, treat of the gold deposits of Rabun, Habersham, Towns, Union, Hall, Gwinnett, Forsyth, Dawson, Milton, Fulton, Cherokee, Bartow, Cobb, Paulding, Douglas, Carroll, Haralson, Gilmer, Fannin, and Lumpkin counties, respectively. Of these, by far the most attention is given to Lumpkin county in as much as it is the chief gold producing county of the State.

The concluding chapter, number XXIII, gives the statistics of Georgia's gold production for the years 1880 to 1895, inclusive, with conclusions on the gold mining industry of the State and its future possibilities.

Bulletin No. 5. A Part of the Phosphates and Marls of Georgia, by S. W. McCallie, 1896.—This bulletin contains 98 pages and is illustrated by 3 plates and 6 figures.

Chapter I is entitled the general distribution of phosphate deposits. It gives a general statement of distribution and history together with notes on the phosphates of the various countries of the world and of the States of the United States.

Chapter II is devoted to a discussion of the various theories that have been advanced as to the origin of phosphates, such as deposition by hot waters in fissures, animal origin, and by collection by meteoric waters.

Chapter III treats of the distribution of phosphate deposits in Georgia. The location and description of various properties is given.

Chapter IV is devoted to general conclusion on phosphate deposits.

Bulletin No. 6. A Part of the Clays of Georgia, by George E. Ladd, 1898.—This bulletin contains 204 pages and is illustrated by 17 plates and 11 figures.

Chapter I, entitled "General Remarks on Clays," gives a definition of clay and classifies clays under two major divisions, Indiginous and Foreign or Transported. The chapter further treats of the ori-

Fig. 1.

Fig. 2.

Fig. 3.

Fig. 4.

Fig. 5.

Fig. 6.

GOLD AND SILVER MEDALS AWARDED THE STATE GEOLOGICAL SURVEY AT THE LOUISIANA-PURCHASE EXPOSITION, ST. LOUIS, 1904, UPON EXHIBITS OF MARBLES (FIG. 1), CLAYS (FIG. 2), BAUXITE (FIG. 3), GOLD NUGGETS (FIG. 4), COLLECTION OF ORES (FIG. 5), AND GEOLOGICAL PUBLICATIONS (FIG. 6).

gin and composition, properties and characteristics, behavior with reference to water and to heat, shrinkage and consolidation on drying, plasticity, uses, and the geographical and geological distribution of clays.

Chapter II deals with the methods of locating and testing clays, It points out the importance of sampling, and outlines the preparation for testing, the special method for separation of clays, and the tests of the behavior of clays with reference to water. It further gives the methods of determining plasticity, the experiments on the behavior of clays with reference to heat, the use of the oxy-hydrogen and the electric furnaces, indirect methods for determining fusibility, and the chemical analysis of clays.

Chapter III deals with the Fall Line clays. The general geological and physiographical conditions and history are set forth in the first part of the chapter. The major portion of the chapter is devoted to notes on the various localities of clay deposits in the State.

Chapter IV is entitled, "A Comparison Between Georgia Clay and Other Well-Known Clays of the United States." It first defines and gives the occurrence and distribution of fire-clay, followed by its geological and geographical occurrence. It then treats in order the clays of New Jersey, Maryland, Pennsylvania, Ohio, Missouri, Colorado, California, Texas, and Georgia, followed with tables of comparison.

There is in addition an appendix containing a bibliography on the subject of clay and its manufacture.

Bulletin No. 7. Artesian Well System of Georgia, by S. W. McCallie, 1898.—This bulletin contains 214 pages and is illustrated by 7 plates, 22 figures and 2 maps.

Chapter I first enumerates the essential conditions of successful artesian wells under the headings of (1) water-bearing strata, (2) confining strata, and (3) rainfall. It next treats in order unsuccessful wells and the causes thereof, the life of, and the uses of artesian wells, the chemical composition of artesian waters, methods of boring and cost of artesian wells. It concludes with some notes on noted wells.

Chapter II is devoted to the artesian wells of South Georgia. There is first given a description of the topography with tables of elevations. This is followed by a condensed general account of the geology of the Coastal Plain. There is then given a history of artesian wells in South Georgia, a description of the water-bearing stra-

ta and a list of artesian wells. The concluding portion of the chapter is devoted to descriptive notes by counties, on artesian wells of South Georgia.

Chapter III deals with the surface wells of South Georgia. The status of conditions is given and the dangers of contamination of the waters is pointed out.

Chapter IV deals with the artesian waters in North Georgia, giving a statement concerning the generally unfavorable conditions for artesian wells in that section of the State.

Chapter V gives the general conclusions as to artesian well prospects in the State and their advantages.

Bulletin No. 8. Roads and Road-Building Materials of Georgia, by S. W. McCallie, 1901.—This bulletin contains 264 pages and is illustrated by 27 plates, 28 figures and 1 map.

Chapter I takes up the history of road construction, beginning with an account and description of the early Roman roads, the roads of the Incas of Peru, and the general trend in road building through succeeding time, including road building activities in the various parts of the United States, together with the impelling causes of road betterment in recent years.

Chapter II is devoted to the value of good roads. The advantages derived by the saving on horses and vehicles and the ease and lowered cost of transportation and the time element are discussed at some length.

Chapter III deals with road construction. It treats first the question of the proper location of roads, the problem of grades, and the problem of drainage and its relation to roads and road building. Next in order is treated the subject of road surfaces, their kinds, construction and foundations.

Chapter IV is given to the subject of the maintenance and repair of roads. The needs of proper care of roads is pointed out, together with suggestions as to maintenance.

Chapter V is devoted to road materials. The various types of road metal, such as traprock, granite, limestone, sandstone, chert, shale, slate, gravel, and shells, are enumerated and their respective merits given.

Chapter VI gives a list and description of the tools and machines used in highway construction.

Chapter VII deals with the topography of Georgia in its relation to the highways. The various types of existing topography are discussed together with the possibilities and difficulties they offer in road building.

Chapter VIII is on the road-building materials of Georgia. These are treated under the three general headings of the road materials of the Paleozoic area, those of the Crystalline belt and those of the Tertiary area. Under the first are discussed the Paleozoic limestones, cherts, shales and sandstones; under the second the granites, gneisses, diorite, diabase, schists, quartzites, marbles, and gravels; under the third the Tertiary limestones, flints, and gravels.

Chapter IX, the concluding chapter, deals with the roads of Georgia, with brief descriptions of the equipment, methods of road-working, and materials, by counties.

Bulletin No. 9. A Part of the Granites and Gneisses of Georgia, by Thomas L. Watson, 1902.—This bulletin contains 368 pages and is illustrated by 32 plates and 4 maps.

Chapter I deals with such general considerations as the definition of granite, its mineral composition and structure, its chemical composition, its varieties and general physical properties, its geological age and mode of occurrence, its history, uses, and origin. It then discusses the geological and geographical distribution of granites in the United States. This is followed by a discussion of the Appalachian region, by States.

Chapter II takes up first the general physical, chemical, and economic properties of building stones, as relating more especially to granite. These are treated under the headings of durability, mineral composition, texture, hardness, strength, structure, color, and geological age. The chapter next takes up the consideration of the criteria for determining the value of stone for general economic work. The means of determining this criteria is discussed under three headings: field study, examination of stone in structures of long standing, and laboratory tests—chemical, microscopic, and physical.

Chapter III is divided into two parts. Part 1 discusses the geology and physiography of the Piedmont Plateau, the rocks and the structure of the Plateau, soils of the Plateau and the age of the Plateau rocks. Part 2 gives general descriptions of individual properties by counties.

Chapter IV discusses the general chemical and lithological characteristics of the Georgia granitic ricks. Under the chemical charac-

teristics are treated chemical composition, analyses, molecular ratios, oxide ratios of the granites, porphyritic granites and granite-gneiss, and mineral constituents of the Georgia granitic rocks. Under lithological characteristics are discussed character of the granitic outcrops, the granites and gneisses. It further treats of the eruptive origin of the Georgia granites, their field relations, weathering, contact phenomena and the conclusions derived from them. It next discusses the gneisses and porphyritic granites, intruded dikes and veins, and the age of the Georgia granites.

Chapter V is divided into two parts. Part 1 is on the general principles of rock-weathering under the agencies of the action of the atmosphere, chemical action of water, mechanical action of water and ice, action of freezing water and ice, and the action of plants and animals. Part 2 is a special consideration of the weathering of the Georgia granitic rocks, treating in order the granites, porphyritic granites and granite-gneisses from selected localities. There follows a statement as to the red color of the soil and a general résumé.

The concluding chapter, No. V, gives statistics of production and value, physical tests, and chemical analyses of the granites and gneisses of Georgia.

Bulletin No. 10. The Iron Ores of Polk, Bartow and Floyd Counties, Georgia, by S. W. McCallie, 1900.—This bulletin contains 190 pages and is illustrated by 8 plates, 22 figures and 1 map. It treats of the varieties, the geographical and geological distribution, the mode of occurrence, the origin, and the methods of mining the iron ores.

Chapter I is divided into seven sections. Section 1 gives the varieties of the iron ores, and their impurities. Sections 2 and 3 give respectively the geographical and the geological distribution of the brown iron ores. Sections 4, 5, and 6 treat in order the mode of occurrence, origin and method of mining the brown iron ores. Section 7 is a discussion of the iron furnaces of Polk, Bartow, and Floyd counties.

Chapters II, III and IV treat in a detailed manner of the description of the iron ore properties of Polk, Bartow and Floyd counties in the order given.

Bulletin No. 11. Bauxite Deposits of Georgia, by Thomas L. Watson, 1904.—This bulletin contains 169 pages and is illustrated by 12 plates, 3 figures and 1 map.

Chapter I takes up first the distribution and general occurrence of bauxite with a brief description of the known workable areas. Brief notes are given on the deposits of France, Germany, Ireland, French Guiana and Arkansas, New Mexico and Georgia-Alabama. There is then given a brief account of the discovery of bauxite in Georgia.

Chapter II deals with the general geology of the bauxite region of Georgia. It treats in order of the topography and stratigraphy, followed by a description of the Cambrian and Silurian rocks. It further treats of the structure of the bauxite region and of the minerals associated with bauxite.

Chapter III is divided into two parts. The first is devoted to the chemical composition of bauxite with tables of analyses, and is concluded by a brief résumé of bauxite. The second part enumerates the varieties of bauxite with brief descriptions of the different kinds.

Chapter IV is on the distribution and description of the individual bauxite deposits in Georgia. These are treated under four main subdivisions: the Hermitage district, the Bobo district, the Summerville district, and isolated deposits.

Chapter V is divided into four sections. Section one is devoted to the genesis of the Georgia bauxite deposits, section two to their age, section three to the method of estimating the ore-bodies and section four to their uses.

Chapter VI is on the technology of bauxite in the manufacture of aluminum and alum. The chapter is divided into two parts. The first deals with the aluminum manufacture, discussing various processes used. The uses of aluminum, and its alloys are discussed and various production statistics are given. Section two deals briefly with the alum manufacture.

Chapter VII is devoted to matters of mining and to the transportation and preparation of the Georgia bauxite for shipment. It takes up in order the discussion of the nature of the deposits to be mined, the present mining methods and machinery, the preparation of the ore previous to shipping, the effects of calcining on the solubility of alumina, the markets and transportation. The chapter closes with suggestions as to future development. A bibliography of bauxite is given.

Bulletin No. 12. Coal Deposits of Georgia, by S. W. McCallie, 1904.—This bulletin contains 121 pages and is illustrated by 14 plates, 60 figures, and 1 map.

Chapter I discusses the carboniferous rocks of Georgia. Somewhat detailed descriptions of the members of the Georgia carboniferous rocks are given. These subdivisions are the Fort Payne chert, Floyd shale, Bangor limestone, Lookout sandstone, and the Walden sandstone.

Chapter II describes the topography of Sand Mountain and Lookout Mountain. Chapter III covers the structural geology of the coal fields, discussing both the major and minor structural features. Chapters IV, V and VI treat in the order named the coal deposits of Walker, Chattooga and Dade counties with descriptions of individual properties in each county.

Chapter VII is entitled "Correlation Notes." In it the attempt is made to give satisfactory correlations of both the lower and upper coal measures of Georgia with those in adjacent parts of Alabama and Tennessee.

Chapter VIII gives a discussion of the chemical properties of the Georgia coals.

Bulletin No. 13. The Ocher Deposits of Georgia, by Thomas L. Watson, 1906.—This bulletin contains 81 pages and is illustrated by 11 plates, two profiles and 15 maps.

Chapter I is on the geology of the Cartersville district, Georgia. It treats, in order, the stratigraphy, structure, and topography of the district. In addition it discusses rock-weathering, and locates and discusses the ore deposits of the district.

Chapter II begins with the geographic and geologic distribution and position of the ocher deposits. There are next given the chemical composition and the physical properties of the ocher. The chapter concludes with the criteria of surface indications of ocher.

Chapter III deals wholly with descriptions of individual properties of the Cartersville district.

Chapter IV is devoted to the genesis of the ocher deposits of the Cartersville district. The conclusions as to the genesis of the deposits are derived from the petrographic study of the Weisner quartzite and the mode of occurrence of the ocher. There is also discussed the source of the iron oxide and the process of replacement that has been effective.

Chapter V deals with the economic phase of the ocher deposits. It gives first an historical sketch of the development of the ocher industry in the district. Following this is given the mining methods,

the preparation of the ore, the transportation problems and facilities, and matters pertaining to fuel and water. The chapter concludes with remarks on the calcined ocher, its uses and markets.

Bulletin No. 14. The Manganese Deposits of Georgia, by Thomas L. Watson, 1908.—This bulletin was the last one to be published under Professor Yeates' administration. It contains 195 pages and is illustrated by 8 plates, 31 figures and 2 maps.

Chapter I is on the distribution of manganese in Georgia. It gives a general survey of previous descriptions, the production, value and uses of manganese, the methods of mining and preparing the ore, and the significance of "Float" ore.

Chapter II is on the manganese deposits of the Paleozoic area. There is first given a résumé of the geology of the area, covering its position, topography, stratigraphy, and structure. Next in order is discussed the Cartersville district, Georgia. The topography, stratigraphy, and structure of the district are treated in considerable detail. There then follows a detailed description of the manganese ore deposits of the Cartersville district.

Chapters III, IV and V all bear the title of the "Manganese deposits of the Paleozoic Area." They contain detailed descriptions of individual localities and properties within the Paleozoic area.

Chapter VI is devoted to the genesis of manganese deposits of the Paleozoic area. The discussion of the genesis takes into account the stratigraphic position of the ores, the character and depth of decay of the rocks, and the mode of occurrence of the ores and their distribution in the clay. There is further discussed the association of the manganese with other ore deposits of the area, the sources of the manganese and the part played by solution, transportation and precipitation of the ore forming material. The concluding remarks are on the local accumulation of the manganese.

Chapter VII is on the manganese deposits of the crystalline area of Georgia. It first locates and describes the crystalline area, together with its rocks, rock-forming minerals and manganese-bearing minerals. The remainder of the chapter is given over to a discussion of individual deposits in the crystalline area.

THE ADMINISTRATION OF PROF. S. W. MC CALLIE

Following the death of Prof. Yeates on February 18, 1908, Prof. S. W. McCallie was appointed to the office of State Geologist, which office he still holds. The personnel of the Survey under Prof. Mc-

Callie's administration has been quite varied, there having been eleven different assistant geologists. Dr. Edgar Everhart has remained as the Survey Chemist since his appointment in 1905. The first assistant geologists under Prof. McCallie's administration were Otto Veatch and S. P. Jones. On July 1st, 1909, Mr. Jones resigned and was succeeded by Dr. T. Poole Maynard, who held office until May, 1912, when Dr. O. B. Hopkins was appointed to fill his place. On February 1st, 1912 Mr. Veatch resigned. He was succeeded by Dr. S. L. Galpin, who held office from June 15, 1912, until the fall of 1914. Mr. J. E. Brantley served as assistant geologist from March 1914, to September 11, 1916. Mr. H. K. Shearer took Mr. Hopkins' place in the fall of 1914 and held office until November 7, 1918. Mr. J. P. D. Hull held office from January 20, 1917, to May 1st, 1920. Mr. Shearer was succeeded by Mr. L. P. Teas who held office from November 7, 1918, until September 13, 1920. The present assistant geologists are Mr. T. M. Prettyman, who was appointed to office in March, 1921, and Mr. H. S. Cave, who was appointed in September, 1921.

During Prof. McCallie's term of office as assistant geologist and State Geologist there have been published under his name 16 Georgia Geological Survey Bulletins. Of these, two were joint publications of Prof. McCallie and others. Besides the said bulletins, Prof. McCallie has published, in various scientific publications, twenty-six additional articles on phases of Georgia geology.

PUBLICATIONS

Under Prof. McCallie's administration the Survey has published 24 bulletins as follows:

Bulletin No. 15. Underground Waters of Georgia, by S. W. McCallie, 1908.—This bulletin contains 376 pages and is illustrated by 29 plates, 5 figures and 2 maps.

Chapter I is an introductory chapter. It outlines the general conditions governing the amount of water taken up by the soils. These conditions are discussed under the headings of the porosity of the soils, effect of surface inclination, rate of precipitation and surface evaporation. The chapter is concluded with the consideration of the rainfall absorbed by the soils.

Chapter II is devoted entirely to the physiographical divisions of the State. These are outlined and a general description of each is

given. The physiographical divisions as given are: the Coastal Plain, the Piedmont Plateau, the Appalachian Mountains, the Appalachian Valley, and the Cumberland Plateau.

Chapter III is a general summary of Georgia geology, emphasizing the stratigraphical phase. The major part of the chapter is devoted to the Cretaceous and Tertiary strata, lying south of the Fall Line, in as much as those are the formations most closely associated with the Georgia underground waters. A smaller portion of the chapter is devoted to the Paleozoic rocks and the undifferentiated crystallines.

Chapter IV gives general notes on the underground waters of the several geological formations of the State. Each major division of the Tertiary and the Cretaceous is treated separately. The crystalline and Paleozoic rocks are each treated as single units.

Chapter V gives the mineral constituents of the deep well waters of the Coastal Plain.

Chapters VI, VII, VIII and IX, all give detailed descriptions of the underground waters of the Coastal Plain by counties.

Chapter X gives detailed notes on the underground waters of the crystalline area. The material is treated under three main headings: (1) Deep wells, (2) Shallow wells, and (3) Springs.

In the same manner Chapter XI treats of the underground waters of the Paleozoic area.

Chapter XI is on an experiment relating to problems of well contamination at Quitman, Georgia. There is first given a statement of the geography and geology of the immediate area. There then follows the description of the experiment, together with a description of stations. There is then discussed the correlation of water-bearing strata, followed by the results and conclusions obtained from the experiment.

Chapter XIII is devoted to Blowing Springs and Wells of Georgia with a discussion of the phenomena. Various individual wells and springs are treated individually.

In addition to the thirteen chapters outlined above, the bulletin contains three appendices. They are as follows:

A. Source of water supply of cities and towns.

B. Miscellaneous spring records.

C. List of fossils from the Coastal Plain of Georgia.

Bulletin No. 16. Water Powers of Georgia, by B. M. and M. R. Hall, 1908.—This bulletin forms a second report on the water powers of Georgia. It contains 424 pages and is illustrated by 14 plates, and 1 map.

The bulletin is very largely of a statistical nature. Pages 17 to 30 inclusive are of a general introductory and explanatory nature. Pages 17 to 20 inclusive treat of the topography and geology of the crystalline area, the Paleozoic area, and the Coastal Plain. Pages 21 to 25 inclusive treat of the uses of water for irrigation, domestic purposes and municipal supply, and for industrial purposes. Pages 25 to 30 inclusive, deal with the water supply of streams as to measurements of flow, definition of terms, explanation of tables, and description of gauging stations.

The entire remaining portion of the bulletin treats in order the drainage basins of the Savannah River, the Ogeechee River, the Altamaha River, the Apalachicola River, the Mobile River, and the Hiwassee River. Under the discussion of each of the above named drainage basins there is given a description of the basin, the stream flows, the various river surveys and a discussion of the water powers. In each case also are given detailed tables of gauging statistics compiled at the various stations.

Bulletin No. 17. Fossil Iron Ore Deposits of Georgia, by S. W. McCallie, 1908.—This bulletin contains 199 pages and is illustrated by 24 plates, 3 figures and 1 map.

Chapter I enumerates and describes the rocks associated with the fossil iron ores. The rocks described are those of the Medina Clinton and Niagara epochs, all of Silurian age.

Chapter II enumerates and describes the rocks of Georgia that were deposited during Niagara time.

Chapter III discusses the distribution of the Clinton Ores in the United States with general descriptions of typical developments at various localities. The almost continuous character of the deposits, reaching from the interior of New York State into northern Alabama, is forcibly emphasized.

Chapter IV treats of the local distribution of the fossil iron ores in Georgia.

Chapter V is devoted to the topography and geology of the iron ore district. There is first discussed the topography, following which is a detailed description of the stratigraphy of the region. The Cam-

brian, Silurian, Devonian, and Carboniferous rocks are treated in detail in the order named. The last portion of the chapter discusses the structural geology of the region.

Chapters VI, VII, VIII, IX and X give general descriptions of the mode of occurrence of the fossil ores together with detailed descriptions of individual properties in Dade, Walker, Chattooga, Whitfield, and Catoosa counties, in the order named.

Chapters XI and XII discuss in order the matter of origin of the fossil iron ores, and the geological conditions which obtained during Clinton (Silurian) time when the deposition of the ores took place.

Chapters XIII and XIV give respectively megascopic and microscopic descriptions of the fossil iron ores, both hard and soft.

Chapter XV is devoted to a discussion of the chemical composition of the Georgia Clinton ores, with tables of analyses.

Chapter XVI, the concluding chapter, gives what the author considers the most probable origin of the Clinton ore, (deposition as glauconite) together with the reasons thereof.

Bulletin No. 18. Clay Deposits of Georgia, by Otto Veatch, 1909.—This bulletin constitutes the second report on the clays of Georgia. It contains 453 pages and is illustrated by 32 plates, 15 figures and 3 maps.

Chapter I is entitled the classification and origin of clays. There is first given the definition of the term clay, followed by a discussion of the origin of clays. The clays are then classified under two major headings; (1) Residual clays and (2) Transported clays. Each class is discussed in some detail. The chapter is closed with a brief statement on chemical deposits.

Chapter II deals with the minerals of clays and with the chemical analysis of clays.

Chapter III takes up the physical properties and the tests of clays. These are discussed under the headings of plasticity, strength, drying, shrinkage, burning tests, texture, and slaking.

Chapter IV gives the geological distribution of the clays of Georgia. There is given a table of geological formation, followed by a general description of each of the divisions represented in the stratigraphic column of Georgia.

Chapter V is on the Cretaceous kaolins and fire clays. The deposits of the various counties are taken up in order.

Chapter VI deals with the properties and uses of the Fall Line white clays, with brief mention of the occurrence of flint and feldspar.

Chapter VII locates and describes the fire clays of the Tertiary formations of the Coastal Plain. The deposits are given in order, by counties.

Chapter VIII deals with the kaolins of the Piedmont region.

Chapter IX is on the kaolins and fire clays of the Paleozoic region of northwest Georgia. There is given a description of the deposits, by counties.

Chapter X is on building brick, sewer pipe, roofing tile, terra cotta, and common pottery clays with descriptions by counties.

Chapter XI discusses the shales of Georgia with descriptions by counties.

In addition to the above mentioned chapters the bulletin contains four appendices. Appendix A gives statistics of the value of clay products and clays of Georgia for the years 1905, 1906 and 1907. Appendix B gives a table of chemical analyses. Appendix C a directory of clay workers. Appendix D is on the bauxite of Wilkinson county.

Bulletin No. 19. Gold Deposits of Georgia, by S. P. Jones, 1909.—This bulletin is a second report on the Georgia gold deposits. It contains 283 pages and is illustrated by 8 plates and 2 maps.

Chapter I is an introductory chapter. It sets forth general conditions pertinent to gold and gold-mining activities and gives a general historical sketch together with statistics of gold production in Georgia.

Chapter II is a consideration of the different types of gold deposits. It gives general notes on vein deposits, placer deposits, black sand, and saprolite deposits.

Chapter III is on the geographical and geological distribution of the gold deposits of Georgia. The locations are considered by counties.

Chapter IV treats of the geology and genesis of the deposits, together with a description of the rocks of the gold regions.

Chapter V takes up the location and description of individual properties which need not here be enumerated.

Bulletin No. 20. Mineral Springs of Georgia, by S. W. McCallie, 1913.—This bulletin contains 190 pages and is illustrated by 24 plates.

This bulletin is divided into two major divisions. The first portion deals with a general consideration of mineral springs and mineral waters. There is given a definition of mineral waters, the origin of mineral springs, a discussion of thermal springs, the medicinal value of mineral waters and a scheme of classification of the said waters. A portion of this first division gives the solid and gaseous constituents of mineral waters and their medicinal effect. It concludes by giving the geographical distribution of mineral springs in Georgia.

The second portion is devoted to descriptions of individual springs and wells in Georgia.

Bulletin No. 21. Limestone and Marls of the Coastal Plain of Georgia, by J. E. Brantley, 1917.—This bulletin contains 289 pages and is illustrated by 18 plates, 14 figures and 1 map.

Part I takes up the physiography, structure and geology of Georgia. There is first delimited the physiographical province known as the Coastal Plain of Georgia. The general geology of the Coastal Plain is discussed, with descriptive notes on the Cretaceous, Tertiary, and Quarternary formations. There then follows a general discussion of limestone, as to origin, varieties, and classification.

Part II is devoted to calcareous deposits in the Coastal Plain of Georgia. These are treated systematically by counties.

Part III is on the uses and preparation of limestone. There is first given the various agricultural uses of limestone and lime, together with the methods of applying it. There is then enumerated the various uses of limestone in industrial chemistry and metallurgy. The remainder of part III is divided into three sections: the quarrying of limestone, the manufacture of lime, and machines for preparing limestone.

There is, in addition, a short appendix on the limestone quarries of North Georgia.

Bulletin No. 22. Brown Iron Ores of Georgia, by S. W. McCallie.—This bulletin is still in process of preparation so that no outline can be given.

Bulletin No. 23. Mineral Resources of Georgia, by S. W. McCallie, 1910.—This bulletin contains 208 pages and is illustrated by 20 plates and 2 maps.

The first portion of the bulletin is devoted to the physiographical features of Georgia. Each of the five major physiographical divisions is outlined and a summary description of each division is given.

The second portion of the bulletin is on the geology of Georgia. Each geological division is delimited and described briefly, beginning with the Pleistocene and descending through the geological column.

The remainder of the bulletin is devoted to the various minerals produced in Georgia. Each type of mineral of economic importance is discussed as to localities of occurrence, geology, history, mining methods and treatment, mineral properties, uses, and statistics of production. There are in all 27 minerals discussed. There is in addition a brief discussion of mineral waters, artesian wells, and an inventory of the water powers of Georgia.

Bulletin No. 24. Public Roads of Georgia, Second Report, by S. W. McCallie, 1910.—This is a short report of 37 pages and contains no illustrations.

The first part of this report is devoted to statistics of mileage, expenditures and other public road data.

There is then discussed the road-building materials of Georgia. These materials are treated under three divisions: the road building materials of the Paleozoic area, of the Crystalline area, and those of the Coastal Plain. Under each division the various materials existing in the given area are treated separately as to kind, amount, desirability, etc.

The remainder of the report is devoted to road construction. It deals with the location of roads, grades, drainage, and road surfaces.

Bulletin No. 25. Drainage Investigations in Georgia, by S. W. McCallie and U. S. Department of Agriculture, 1911.—This bulletin contains 123 pages and is illustrated by 7 plates and 5 maps.

The first part of this bulletin deals with general drainage conditions in Georgia. These are treated under the headings of swamp lands, overflow lands, wet lands, and salt marsh lands.

There is next taken up the investigation of drainage conditions by the State, followed by a statement of the work done by the Federal Government.

The remainder of the bulletin is devoted to details of the drainage examinations made, and the work done in various localities of the State.

Bulletin No. 26. Geology of the Coastal Plain of Georgia, by Otto Veatch and Lloyd William Stephenson, 1911.—This bulletin was prepared in co-operation with the U. S. Geological Survey and is one of the most comprehensive publications of the Georgia Geological Survey. It contains 463 pages and is illustrated by 30 plates, 13 figures and 2 maps.

There is first taken up the enumeration of the physiographical divisions of Georgia, followed by a somewhat detailed statement of the geology of the Coastal Plain. The divisions of the Coastal Plain strata are set forth together with thickness and structure.

After the statement of general conditions as outlined above the geology and stratigraphy of the Coastal Plain is taken up in detail Each of the geological formations and its component members is discussed in detail. The formations are taken in order, from the Lower Cretaceous on up through the stratigraphic column. Detailed lithologic descriptions, thickness, and many detailed sections are given. Attempts are made to give satisfactory correlations of the various strata on the basis of lithology, paleontological evidence and superposition.

Bulletin No. 27. Limestones and Cement Materials of North Georgia, by T. Poole Maynard, 1912.—This bulletin contains 296 pages and is illustrated by 22 plates, 6 figures and 1 map.

The first section is a general treatise on limestones, clays, shales and slates. The origin of limestone, the kinds, characteristics—physical and chemical,—and the various uses of limestone and lime are treated in some detail. In like manner clays, shales and slates are discussed.

There is next treated the hydraulic limes and natural and Portland cement. Each is considered from the standpoint of raw material, composition, treatment, properties, etc.

The third section of the bulletin is on the physiography, structure and geology of North Georgia. The major physiographical divisions of the State are outlined and their major structural features given. The geology of North Georgia is treated in a much more detailed manner. Each geologic member is discussed as to areal distribution, lithologic character, and paleontology.

The fourth section of the bulletin is on the limestone and cement materials of the Piedmont Plateau and Appalachian Mountain areas in Georgia. The geology and description of the various individual properties is given by counties. In like manner section five deals

with the limestones and cement materials of the Appalachian Valley and the Cumberland Plateau areas in Georgia.

There is, in addition, an appendix containing United States Government specifications for Portland Cement, and interpretation of results.

Bulletin No. 28. Public Roads of Georgia, by S. W. McCallie, 1912.—This is a third report on the Public Roads of Georgia. It contains only 12 pages and is without illustrations.

It gives the estimated public road mileage of the State of Georgia in 1911 as 83,986, which is an increase of 1,704 miles over the road mileage of 1909. Statistical data, by counties, is given as to mileage, cost, labor, etc.

Bulletin No. 29. Asbestos, Talc, and Soapstone Deposits of Georgia, by Oliver B. Hopkins, 1914.—This bulletin contains 319 pages, and is illustrated by 21 plates, 7 figures and 1 map.

Part 1 is on general geology and petrography. It first outlines the general geology of the State. The crystalline area is discussed at some length as to location, physiography, and stratigraphy. There is then discussed the peridotites, pyroxenites and associated basic rocks. Their distribution, character, relations and petrography are given. There then follows a description of the rock alterations and the products thereof, together with the matter of origin and relations, and age of intrusion.

Part II is on the asbestos deposits of Georgia. There is first given the significance of the term "asbestos" with an historical sketch of the mineral. There are then enumerated the asbestiform minerals, with their chemical and mineralogical characteristics. Next discussed are the types of asbestos, modes of occurrence, origin, mining and milling methods, production and uses. Then follows general notes on the asbestos deposits of North America, by countries and States. The closing portion of part II gives detailed descriptions of Georgia deposits, by counties.

Part III is headed "Talc and Soapstone Deposits of Georgia." Their chemical and physical properties are first given, followed by the enumeration of the varieties of talc. There is then treated the matter of origin, and the mining and milling methods used, together with a statement of production and uses. There is next given a statement concerning the talc deposits by States. The talc deposits of Georgia are then treated by counties. The remainder of Part III

Fig. 1.

Fig. 2.

Fig. 3.

Fig. 4.

Fig. 5.

Fig. 6.

MEDALS AWARDED THE STATE GEOLOGICAL SURVEY AT THE TRANS-MISSISSIPPI AND INTERNATIONAL EXPOSITION, OMAHA, 1898. FIGURES 5 AND 6 REVERSE OF FIGURES 3 AND 4.

is devoted to detailed descriptions of the soapstone deposits of Georgia by counties.

There is also given a bibliography of asbestos and of talc and soapstone. There is an appendix on the sericite and chlorite schists of Pickens and Cherokee counties.

Bulletin No. 30. Feldspar and Mica Deposits of Georgia, by S. L. Galpin, 1915.—This bulletin is a preliminary report. It contains 192 pages and is illustrated by 9 plates, 3 figures and 1 map.

Part I is divided into 2 chapters. Chapter I is on the crystalline area. It gives the location, physiography, structure, and detailed notes on the geological formations. Chapter 2 is on Pegmatite. There is outlined its occurrence, composition, structure, and origin. There are also given the useful minerals of pegmatites with their uses, impurities, tests, quarrying, treatment, etc.

Part II is on the feldspar and mica in the Georgia pegmatites. The deposits are taken up by counties. Detailed descriptions are given of the geology, the pegmatites, their minerals, and associated rocks.

There are in addition three appendices as follows: (1) Abstracts of patents issued by the United States Patent Office on methods for extracting potash and other substances from silicate rocks and minerals, especially feldspar, (II) Ground feldspar as a commercial fertilizer, (III) Chert deposits of Georgia.

Bulletin No. 31. Bauxite and Fuller's Earth of the Coastal Plain of Georgia, by H. K Shearer, 1917.—This bulletin contains 332 pages and is illustrated by 32 plates, 24 figures and 1 map.

The first section of the report is an introduction outlining the general topographical, physiographical, and geological features of the Coastal Plain of Georgia. The geological formations are given, with brief descriptions of each.

Part I is on bauxite deposits. It begins with the definition of bauxite, its occurrence and distribution by countries of the world and by States of the United States. There is then taken up the discussion of the bauxite deposits of Georgia. These are treated by geological formations. Descriptions of individual deposits in each formation are given.

In like manner Part II deals with the Fuller's earth deposits.

In addition there are, in this bulletin, the following three appendices: A. Bauxite deposits of Meriwether county. B. Notes on the bauxite deposits of North Georgia. C. Notes on halloysite.

Bulletin No. 32. Agricultural Drainage in Georgia, by J. E. Brantley and U. S. Department of Agriculture, 1917.—This bulletin contains 117 pages and is illustrated by 18 plates and 6 maps.

The report first gives a general statement of the drainage characteristics of Georgia— its physiography, drainage outlets and climate.

There is then taken up the drainage of the Piedmont Plateau, as to natural drainage, the general drainage problem, construction and maintenance of drainage systems, and descriptions of typical projects in the Piedmont.

In like manner the drainage of the Coastal Plain is treated. In addition is given an abstract of the Drainage Law of Georgia and amendments thereto.

Bulletin No. 33. A Preliminary Report on a Part of the Pyrites Deposits of Georgia, by J. P. D. Hull and H. K. Shearer, 1918.— This bulletin contains 224 pages and is illustrated by 17 plates, 20 figures and 1 map.

There is first given a general statement as to pyrite, its history, uses, production and imports. Following this is a general outline and description of the geology of North Georgia.

There is then taken up the subject of pyrite deposits. The various types of deposits and their distribution is given. The entire remaining portion of the bulletin is devoted to the description of individual pyrites deposits in Georgia, by counties.

Bulletin No. 34. Slate Deposits of Georgia, by H. K. Shearer, 1918.—This bulletin contains 188 pages and is illustrated by 26 plates, 8 figures and 3 maps.

There is first given an historical sketch of slate, together with its production and a statement of the present condition of the slate industry in the United States.

The next portion of the bulletin is devoted to the general subject of slate. It is defined and classified under two major divisions which are (1) Aqueous sedimentary, and (2) Igneous. There then follows the enumeration of the physical characteristics of slate, such as, texture, bedding, cleavage, grain joints, faults, veins and dikes. Following the physical description is given its chemical composition, chemical changes in weathering, mineralogical composition, age and geological relations, and its origin. The first section is concluded by a statement relative to methods of testing and working slate, and the enumeration of its uses.

The second section of the bulletin deals especially with the slate deposits of Georgia. These are treated first from the standpoint of location, structure, geology and stratigraphy. The remainder of the bulletin proper gives descriptions of individual properties by districts.

There is in addition an appendix devoted to the sericite deposits of Pickens county. Their location, general relations, mode of occurrence, and origin are given. The appendix is concluded with descriptions of individual deposits.

Bulletin No. 35. Manganese Deposits of Georgia, by J. P. D. Hull, Laurence LaForge and W. R. Crane, 1919.—This bulletin constitutes the Survey's second report on Manganese. It contains 290 pages and is illustrated by 21 plates, 26 figures, and 2 maps.

The report first considers the general properties of manganese. It gives a definition of the metal, lists the manganese ores and the principal manganese minerals, and gives the various uses of manganese. There then follows a general statement relative to the manganese mining industry. Under this heading is given an historical sketch, amount of imports, the production of the United States as a whole, the production by States and by Georgia.

There is then taken up the consideration of the Georgia deposits. Under this portion of the report there is first given the types of deposits. There is then outlined the principal theories of origin. The manganese content of the rocks of Georgia is then considered, together with the statement of distribution.

The major portion of the bulletin is devoted to the descriptions of the various individual districts of Georgia, as to topography, geology, structure and geological history.

The closing portion of the report is given over to a discussion of mining methods and the cleaning of the ore in the Cartersville district, with costs of production.

There is, in addition, an appendix giving the schedule of prices and a list of the principal shippers of manganese and manganiferous ores in Georgia in 1918.

Bulletin No. 36. Barytes Deposits of Georgia, by J. P. D. Hull, 1920.—This bulletin contains 146 pages and is illustrated by 21 plates, 17 figures and 4 maps.

There is first given the general considerations of the mineral barytes, its deposits, geographic distribution, uses, production, imports and consumption.

There then follows the description of the Georgia deposits. These are treated as to general location, geological associations, types of deposits, origin, and distribution.

The remainder of the bulletin is devoted to the description of individual barytes deposits in Georgia, by counties.

Bulletin No. 37. Sand and Gravel Deposits of Georgia, by L. P. Teas, 1921.—This is a preliminary report containing 392 pages and illustrated by 20 plates, 13 figures and 1 map.

The first 43 pages give the nature, classification and properties of sand and gravel. There is given in detail the properties of sand and gravel together with a general classification of sand according to origin, chemical and mineralogical content, grain size, and use. The various ways in which sand and gravel may be utilized, such as, for building purposes, glass making, surfacing roads, pavement foundation, and abrasive uses, are described.

There are further treated in detail the methods of transportation, production, and preparation, together with an outline of the methods to be used in prospecting for sand and gravel.

The closing portion of the report is devoted to the distribution of sand and gravel in Georgia, by geological provinces.

There are, in addition four appendices as follows: A. Sap Brown. B. Black sand. C. Singing sand. D. Molding sand.

Bulletin No. 38. Water Powers of Georgia, by B. M. Hall and M. R. Hall, 1921.—This bulletin, the most recent of the Survey's publications, constitutes the third report on the water powers of Georgia. It contains 316 pages and is illustrated by 11 plates and 4 maps.

The first 12 pages give an estimate of the water powers of Georgia. The net 10 hour horse-power at low water average is shown to be 1,743,650, while the safe average daily output in 10 hour horse-power is 2,381,000.

There then follows a list of the developed water powers of the State, with general descriptions of each, and its output.

The remainder of the bulletin deals with the various river drainage basins of the State. The location of power sites for each basin is given, with the possibilities thereof. There are further given numerous tables of flowage and power statistics compiled from the data obtained at the various gaging stations.

SUMMARY.

From the review of the bulletins which have been published by the Geological Survey of Georgia it will be readily seen that the work of the Survey has been almost entirely of an economic nature. Of the 38 bulletins issued, 26 are on subjects of economic geology, 8 on water resources and drainage, 3 on public roads and road materials, and one strictly scientific report. This latter, bulletin 26, the Geology of the Coastal Plain of Georgia, while directly of a scientific nature, yet has important economic aspects in that the detailed stratigraphy which it contains has a direct bearing on the clay, fuller's earth, bauxite, and the petroleum possibilities of South Georgia.

It is this last named phase of economic geology which is at present receiving the most marked attention of the Survey. At the present time the detailed structure of the Coastal Plain of Georgia is being worked out with the view of locating possible structures that may be favorable to oil accumulation.

SURVEY EQUIPMENT.

One of the absolutely essential parts of any geological survey is its equipment for both field and laboratory work. The equipment of the Georgia Geological Survey consists of field equipment, office fixtures, laboratory equipment, library, and the publications of the Survey. These latter are the means of presenting the results of the work done to the people of the State and others interested, and are accordingly included as a part of the Survey's equipment.

The following is a list of the equipment on hand at the date of writing:

FIELD EQUIPMENT.

		Estimated value
1	Barograph	$ 72.00
9	Cameras	400.00
1	Transit	150.00
1	Stereopticon	150.00
300	Lantern slides	150.00
3	Brunton compasses	75.00
3	Gurley compasses	75.00
2	Aneroid barometers	50.00
1	Dipping needle	25.00
1	Plain table	35.00
1	Field glass	20.00
1	Lock level	8.00
1	Pedometer	5.00
Camp Equipment		100.00
2	Ford cars (used)	500.00
		$1743.00

OFFICE FIXTURES.

73	Sectional Book Cases	$ 500.00
4	Office desks	100.00
8	File cases	200.00
	Miscellaneous	200.00
	Total	$1000.00

LABORATORY EQUIPMENT.

	Chemical laboratory equipment including assay furnace	$1529.00
2	Microscopes	250.00
1	Enlarging camera	30.00
		$1809.00

THE SURVEY LIBRARY.

The growth of the Survey's library has paralleled the existence of the present Survey, dating back to 1889, until at the present time there are listed nearly six thousand publications and nearly two thousand topographic sheets, maps and folios.

The major portion of the publications are contained in the office of the State Geologist and a minor portion in the assistants' office. The publications are arranged in order by states and by divisions in the case of the federal government publications, thus making them readily accessible.

The following is a list of the books in the library:

List of Reference Books in the Library

Text Book Geology—Geikie.
Geology—Vol. I, II, III—Chamberlin and Salisbury.
Manual of Geology—Dana.
Elements of Microscopy—Chamot.
Igneous Rocks, Vol. I and II—Iddings.
Treatise on Ceramic Industries—Bourry.
Phosphates of America—Wyatt.
A Chemical Engineer's Pocketbook—Kent.
A Mining Engineer's Handbook—Peele.
Chemistry of Pottery—Langenbeck.
Manual of Style—Miller.
Techno-Chemical Analysis—Lung and Cohn.
Mineral Waters of United States—Crook.
Geology of Petroleum—Emmons.
Field Methods in Petroleum Geology—Cox, Drake, Muillenburg.
Practical Oil Geology—Hager.
Petroleum Handbook—Andros.
Petroleum, Asphalt, and Natural Gas—Kansas City Testing Laboratory.
Handbook for Field Geologists—Hayes.
Meteorites—Farrington.
Manual of Qualitative Chemical Analysis—Fresenius.
Iron Ores of Great Britain and Ireland—Kendall.
Economic Geology of United States—Ries.

Natural Parks of United States—U. S. Geol. Survey.
Putnam's Word Book—Flemming.
Mineral Springs of United States and Canada—Walton.
Handbook of Georgia—James.
Commonwealth of Georgia—Henderson.
Text Book of Mineralogy—Dana.
Text Book of Geology—Pirsson and Schuchert.
Statistics of Georgia—White.
Treatise of Ore Deposits—Phillips and Lewis.
Microscopical Physiography of Rock Making Minerals of South Carolina —Sloan.
Report of National Conservation Commission Vol. I and II.
Mineral Deposits—Lingren.
Kerl's Assayer's Manual—Garrison.
Genesis of Ore Deposits—Posepny.
Comprehensive Atlas of World—Hammond.
College Physics—Kimball.
Flotation Process—Rickard.
Topography, Strategraphy in the War—Johnson.
Portland Cement—Butler.
American Men of Science—Catell and Brinkall.
Georgia's Landmarks, Memorials, Legions, Vol. I and II—Knight.
Ore Deposits of U. S.—Kemp.
National Geographical Society Monographs.
Stones for Building and Decoration—Merrill.
A System in Mineralogy—Dana.
Third Appendix to Dana's System in Mineralogy—Ford.
Georgia, Historical and Industrial—Stevens.
Dictionary of Altitudes in United States—Gannett.
Determinative Mineralogy and Blowpipe—Brush.
Qualitative Analysis—Miller.
Practical Notes on Cyanide Process—Bosqut.
The Microscope of Drinking Water—Whipple.
Determination of Rock Forming Minerals—Johannsen.
Geographical Essays—Davis.
Gems and Gem Minerals—Farrington.
An Introduction to Geology—Scott.
Life of James Hall—Clarke.

List of Publications in the Library Proper

	No. of Copies
Alabama Geological Survey	46
Arizona Geological Survey	27
Arkansas Geological Survey	20
California State Mining Bureau	63
Colorado Geological Survey	33
Colorado School of Mines	33
Connecticut Geological Survey	35
Florida Geological Survey	20
Illinois Geological Survey	84
Iowa Geological Survey	42
Indiana Geological Survey	30
Idaho Bureau of Mines	8
Kansas Geological Survey	27
Kansas University Quarterly	19
Kentucky Geological Survey	51
Maryland Geological Survey	33

Michigan Geological Survey	53
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American Geologist	94
Annual Report U. S. National Museum	13
Australian Geological Survey	95
British Columbia Geological Survey	10
Boletin de Petroleó	7
Bull. Amer. Inst. Mining Engineers	32
Bull. Geological Society of Amer.	39
Canada Geological Survey	86
Canada Department of Mines	56
Canada Museum Bulletins	76
Canada Yearly Summary Reports	54
Department of the Interior. Miner's Circular	23
Department of the Interior. Technical Paper	308
Engineering and Mining Journal	25
Field Operations. Bureau of Soils	15
Geological Institute of France	25
Geological Survey of Great Britain	75
Good Roads Magazine	10
Hawaii Agriculture Experiment Station	51
Journal Franklin Institute	96
Manufacturers' Record	25
Mining Congress Journal	16
Nova Scotia Institute Science	14
Mexico Institute of Geology	105
Popular Science Monthly	21
Tasmania Department of Mines	60
Tasmania Geological Survey	26
Transactions Amer. Inst. Mining Engineers	42
U. S. Geological Survey Bibliographies	5
U. S. Geological Survey Bulletins	1360
U. S. Geological Survey Depart. of Mines	193
U. S. Geological Survey Mineral Resources	32

U. S. Geological Survey Monographs	39
U. S. Geological Survey Professional Papers	247
U. S. Geological Survey Sheets and Folios	1932
U. S. Geological Survey Water Supply Papers	645
United States Census Reports	18
U. S. Coast and Geodetic Survey	25
Coal Deposits of the World	3
Bulletins Bureau of Soils	26
Bureau Biological Survey Bulletins	40
Experiment Station Records	30
Farmers' Bulletins	50
Forest Service Bulletins	35
National Parks Bulletins	10
Office of Public Roads Bulletins	50
Soil Surveys	55
Totals	7885

Topographic Maps.

Acworth, Ga. Sheet.—14½x17½ inches, scale 1:62,500, contour interval 50′. U. S. Geol. Surv., 1909.

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Stevenson, Ala.-Tenn. Sheet.—14½x17½ inches, scale 1:125,000, contour interval 100′. U. S. Geol. Surv., 1895.

Suwanee, Ga. Sheet.—14½x17½ inches, scale 1:125,000, contour interval 100′. U. S. Geol. Surv., 1894, 1907.

Talbotton, Ga. Sheet.—14½x17½ inches, scale 1:125,000, contour interval 50′. U. S. Geol. Surv., 1907.

Talking Rock, Ga. Sheet.—14½x17½ inches, scale 1:62,500, contour interval 50′. U. S. Geol. Surv., 1916.

Tallapoosa, Ga.-Ala. Sheet.—14½x17½ inches, scale 1:125,000, contour interval 100′. U. S. Geol. Surv., 1897, 1905.

Walhalla, Ga.-N. C.-S. C. Sheet.—14½x17½ inches, scale 1:125,000, contour interval 100′. U. S. Geol. Surv., 1892, 1910.

Wedowee, Ala.-Ga. Sheet.—14½x17½ inches, scale 1:125,000, contour interval 50′. U. S. Geol. Surv., 1902, 1914.

In addition to the topographic maps here enumerated there are in the library several hundred topographic sheets of other states and also a large number of Geological folios, all of which were prepared by the Federal Geological Survey.

Soil Surveys.

Bainbridge Area.—Soil Survey and maps, U. S. Dept. Ag., 1905.
Ben Hill County.—Soil Survey and map, U. S. Dept. Ag., 1913.
Bullock County.—Soil Survey and map, U. S. Dept. Ag., 1911.
Burke County.—Soil Survey and map, U. S. Dept. Ag., 1919.
Chatham County.—Soil Survey and map, U. S. Dept. Ag., 1912.
Chattooga County.—Soil Survey and map, U. S. Dept. Ag., 1913.
Cobb County.—Soil Survey and maps, U. S. Dept. Ag., 1901.
Columbia County.—Soil Survey and map, U. S. Dept. Ag., 1912.
Covington, Ga.—Soil Survey and map, U. S. Dept. Ag., 1901.

Crisp County.—Soil Survey, Ga. State College Ag., 1919.
DeKalb County.—Soil Survey and map, U. S. Dept. Ag., 1915.
Dougherty County.—Soil Survey and map, U. S. Dept. Ag., 1913.
Franklin County.—Soil Survey and map, U. S. Dept. Ag., 1919.
Fort Valley Area.—Soil Survey and map, U. S. Dept. Ag., 1904.
Glynn County.—Soil Survey and map, U. S. Dept. Ag., 1912.
Gordon County.—Soil Survey, U. S. Dept. Ag., 1914.
Grady County.—Soil Survey and maps, U. S. Dept. Ag., 1909.
Habersham County.—Soil Survey and map, U. S. Dept. Ag., 1914.
Hancock County.—Soil Survey and map, U. S. Dept. Ag., 1910.
Jackson County.—Soil Survey and map, U. S. Dept. Ag., 1915.
Jasper County.—Soil Survey and map, Ga. State College Ag., 1918.
Jeff Davis County.—Soil Survey and map, U. S. Dept. Ag., 1914.
Jones County.—Soil Survey and map, U. S. Dept. Ag., 1914.
Laurens County.—Soil Survey and map, U. S. Dept. Ag., 1916.
Meriwether County.—Soil Survey and map, U. S. Dept. Ag., 1917.
Miller County.—Soil Survey and map, U. S. Dept. Ag., 1914.
Pike County.—Soil Survey and map, U. S. Dept. Ag., 1910.
Polk County.—Soil Survey and map, U. S. Dept. Ag., 1916.
Spalding County.—Soil Survey and map, U. S. Dept. Ag., 1905.
Stewart County.—Soil Survey and map, U. S. Dept. Ag., 1915.
Sumter County.—Soil Survey and map, U. S. Dept. Ag., 1911.
Talbot County.—Soil Survey and map, U. S. Dept. Ag., 1914.
Tattnall County.—Soil Survey and map, U. S. Dept. Ag., 1915.
Thomas County.—Soil Survey and map, U. S. Dept. Ag., 1909.
Troup County.—Soil Survey, U. S. Dept. Ag., 1913.
Walker County.—Soil Survey and map, U. S. Dept. Ag., 1911.
Wilkes County.—Soil Survey and map, U. S. Dept. Ag., 1916.

The estimated value of the books, pamphlets, and maps in the Survey Library has been placed at $5,000.

Survey Bulletins on hand January, 1922.

The following is a list of the publications of the State Geological Survey on hand at the beginning of the present year:

	Unbound Copies	Bound Copies
Bull. No. 1—Marble of Georgia	932	...
Bull. No. 2—Corundum Deposits of Ga.	88	...
Bull. No. 3—Water-Power of Ga.	355	...
Bull. No. 6—Part of Clays of Ga.	600	268
Bull. No. 7—Artesian Well System of Ga.	287	385
Bull. No. 8—Roads and Road-Building Material	1237	32
Bull. No. 9—Part of granite and gneisses	1354	...
Bull. No. 10—Iron ores of Polk, Bartow, Floyd Co.	1106	...
Bull. No. 11—Bauxite Deposits of Ga.	500	504
Bull. No. 12—Coal Deposits of Ga.	866	691
Bull. No. 13—Ocher Deposits of Ga.	829	310
Bull. No. 14—Manganese Deposits of Ga.	932	434
Bull. No. 15—Underground waters of Ga.	1051	446
Bull. No. 16—Water Powers of Ga.	1105	279
Bull. No. 17—Fossil Iron Ore of Ga.	1275	573
Bull. No. 18—Clay Deposits of Ga.	564	272
Bull. No. 19—Gold Deposits of Ga.	917	426
Bull. No. 20—Mineral Waters of Ga.	1193	407
Bull. No. 21—Limestone and Marls of Ga.	759	320
Bull. No. 23—Mineral Resources of Ga.	279	23
Bull. No. 25—Drainage Investigation in Ga.	499	...
Bull. No. 26—Geology of Coastal Plain of Ga.	754	...

Bull. No. 27—Limestone and Cement Materials of North Georgia	788	489
Bull. No. 29—Asbestos, Talc and Soapstone, about	1000	...
Bull. No. 30—Feldspar and Mica Deposits in Ga.	233	189
Bull. No. 31—Bauxite and Fuller's	359	64
Bull. No. 32—Agriculture Drainage	802	...
Bull. No. 33—Pyrites Deposits of Ga.	426	214
Bull. No. 34—Slate Deposits of Ga.	654	...
Bull. No. 35—Manganese Deposits of Ga.	342	269
Bull. No. 36—Bartyes Deposits of Ga.	427	308
Bull. No. 37—Sand and Gravel Deposits of Ga.	833	415
Bull. No. 38—Water-Powers of Ga.	492	328
	Grand Total	31,626

The value of the Survey reports on hand is estimated at $20,000.

THE STATE MUSEUM

By the act of the legislature, in 1889, reviving the office of State Geologist, it was specified that part of his duty was to be the work of collecting, analyzing, and classifying specimens of minerals, plants and soils, and causing to be preserved, in a museum, specimens illustrating the geology, mineralogy, soils, plants, valuable woods, and whatever else might be discovered in Georgia of scientific or economic value.

In spite of the fact that the above cited provision was made, there was nothing done in the way of establishing a museum for several years. In Prof. Yeates' administrative report for the year ending October 23, 1894, he made the following statement: "The law, reviving the Geological Survey of Georgia, provided for the collection of specimens of minerals, rocks, ores, and fossils, by the Survey, to establish a state museum, but no provision was made for the museum. In this day of advancement, there are few states but have large and spacious rooms devoted to the State Museum. It is especially unfortunate that Georgia should be among those few that have no state museum; for hardly any state in the South has such mineral resources, as this state. The State Museum can be made a great benefit, not only in advertising to the outside world the mineral and agricultural wealth of the state, but also as a means of educating the people at large, as to the character, the proper classification and the condition, in which the minerals, rocks, ores, fossils, etc. are found, and as to the large variety in the state's forestry, horticulture, pomology, agriculture, etc. It is greatly to be desired that the legislature, at some day not far remote, shall make suitable provision for a State Museum worthy of the great State of Georgia."

The State Legislature, up to the present time, has never acted upon the above recommendation. In 1895 the Governor did, how-

ever, designate the corridors of the third floor of the Capitol building as temporary quarters for the museum. Unfortunately no other quarters have ever been provided.

No systematic work of establishing a State Museum had been undertaken previous to 1895. There had been, however, a small collection, made by the department of agriculture, which was open to the public. In 1895, from September 18 to December 31, there was held in Atlanta the Cotton States and International Exposition. The material collected for the State exhibit was turned over to Prof. Yeates to be used as the nucleus of the State Museum. This was the beginning of the present State Museum. It has been added to from time to time from exhibits made by the State Geological Survey at other expositions and by collections made by the individual members of the Survey.

There are probably very few, if any, of the states in the United States, that have museums that illustrate their economic resources as completely and on so comprehensive a plan as the Georgia Museum illustrates the economic resources of Georgia. The material, although mainly gathered together by the Geological Survey, does not consist merely of minerals, ores, and their products, but of diversified economic resources. The departments embraced in the Museum are: (1) economic geology and mineralogy, (2) forestry, (3) agriculture, (4) education, (5) entomology, (6) ethnology.

The economic geology and mineralogy exhibit consists of a systematic collection of minerals and ores, of clays and clay products, and a special collection of gold nuggets and gems. The collection of gold nuggets is of unusual interest. It contains 25 nuggets ranging in size up to ninety-seven penny-weights. They show various degrees of rounding and polishing by streams and gravel action. The gold nuggets and the specimens of auriferous quartz give a brief, but concise idea of the gold bearing quartz of the Appalachian region and furnish an opportunity for one to familiarize himself with the occurrence of gold in that section, in so far as can be seen without field study. There are also to be seen specimens of free-milling and refractory ores, and also the various stages of the decomposition of auriferous pyrite above ground water level.

The arrangement and display of the economic geological and mineralogical exhibit is as follows:

(1) A systematic mineral exhibit of 994 specimens arranged in eight slope top cases.

(2) A commercial mineral exhibit of 373 specimens arranged in four flat top cases.

(3) A gem case containing specimens of several types of gem materials, including garnet, amethyst, agate, beryl, topaz, moonstone, jasper, etc.

(4) A case containing 25 gold nuggets, 25 specimens of free gold in quartz, one gold coin, 27 bronze medals, and a fragment of the Pickens county meteorite.

(5) An exhibit of commercial minerals and their products, numbering 233 specimens arranged in six Kensington cases.

(6) An exhibit of large size commercial minerals numbering 333 specimens arranged in nine large wall cases.

In the mineral collection, probably every mineral, whether of economic value or not, that has ever been discovered in the State, is represented.

The exhibit of the clays and their products shows the various types of clays obtained from beds of Cretaceous age in Central Georgia, together with a varied collection of aluminum articles, and also bauxite which is the chief ore of this metal.

The Paleontological collection, while not large is, however, interesting to visitors of the museum. It consists of fossil shark's teeth, horse teeth, fossil wood, bones, and invertebrate fossils. The elephant teeth are of special interest in that they furnish unquestioned evidence of this portion of North America having been formerly one of the native homes of the Tertiary elephant.

In the geological department of the museum there is also a fine collection representing Georgia's justly famous building-stones. This collection consists of 85 eight-inch cubes mounted on wooden blocks, of which each face is differently finished, 14 slabs of marble mounted on wall spaces, 4 marble columns with corinthian caps, and several massive pieces of marble and granite on pedestals. Conspicuous on account of their beauty, are 4 large slabs of dark creole marble sawed from one piece and mounted so that the patterns in the grain of the stone match.

The forestry of the State is represented by 165 sections of trees. The lower half of these shows the natural trunk, while the upper portion is cut and polished. There are, in addition to these, 28 polished planks showing finish and a number of manufactured articles, among which is a mantel made of selected curly pine. On each tree trunk is a map showing the distribution in the State of the particular specie.

The agricultural exhibits include displays of cotton, grain, fruits, nuts, etc. One of the most interesting of the agricultural specimens

is a cotton stalk which is said to have on it more than 700 bolls. Another agricultural exhibit of special interest is a collection of 32 different varieties of Georgia pecan nuts.

The educational exhibit consists of specimens of work done by the pupils in a number of the public schools and educational institutions of the State. These exhibits are mounted on hinged frames with cases below for the display of basket work and other articles illustrating manual training. There is also a small exhibit of birds and bird eggs gathered together by the State Game Warden.

The entomological exhibits show a large number of the various plant diseases and insects injurious to crops and forests in Georgia. Various harmful insects are displayed, together with specimens of injured vegetation. The exhibits are further amplified by literature and illustrations.

The ethnological exhibit is the most limited of the various exhibits. It consists of implements, bowls, pipes, etc., of the aboriginese who formerly inhabited Georgia. Of the ethnological material the most valuable is an Indian idol, perhaps one of the most famous of its kind in existence.

Medals and Diplomas.—In addition to the various exhibits above referred to there are also in the museum a large number of medals and diplomas awarded to the State Geological Survey by the various national and international expositions. These medals and diplomas are illustrated by half-tone cuts throughout this report.

One of the most noteworthy features of the museum is the very careful labelling, showing both the name and the locality of occurrence of the various specimens.

Estimated Value of the Museum.—A statement of the value of the specimens and cases in the Museum, which are all of mahogony, is difficult to give. Many of the specimens could never be adequately replaced, so that their money equivalent is often far greater than their intrinsic value. Fair estimated values are as follows: Value of cases in the Museum, $10,600; systematic mineral exhibit, $1,242; commercial mineral exhibit, $1,140.25; Gems, $156; gold nuggets, free gold, and medals, $995; large commercial minerals, $1,650; educational exhibit, $250; wood specimens, $1,670; marble specimens, $1,000; building stones, $840; large ore specimens, $305; relics, $103; fossils, rocks, etc., $242. The total value of the specimens in the Museum is thus placed at $9,594. This, with the value of the cases, gives a grand total of $20,192.

DIPLOMAS AWARDED THE STATE GEOLOGICAL SURVEY AT THE LOUISIANA-PURCHASE EXPOSITION, ST. LOUIS, 1904.

Until more adequate museum quarters are provided, no great additional material can be added to the present collection because of lack of room in which to display it.

The Museum today, which is so largely the result of the work and skill of the late Prof. Yeates and Prof. McCallie, is one of which every Georgian should be justly proud.

Summary

Value of Field Equipment	$ 1,743.00
Value of Office Fixtures	1,000.00
Value of Laboratory Equipment	1,809.00
Value of Library	5,000.00
Value of Georgia Survey Reports on hand	20,000.00
Value of cases and specimens in Museum	20,194.45
Total	$49,746.45

ECONOMIC ORES AND MINERALS OF GEORGIA WITH STATISTICS OF PRODUCTION, VALUE, AND PRODUCERS.

In the following section the various ores and minerals of economic importance, that are now mined in Georgia, are listed. There is given for each, a brief statement as to location, together with a short résumé of the history of the particular industry. The statistics of production and value, and the list of producers in 1921 are given in each case where such data is available. All statistics are from the U. S. Geological Survey, Mineral Resources, which in the last few years have been collected in cooperation with the State Survey.

ASBESTOS

The most important deposits of asbestos in Georgia are in White, Habersham and Rabun counties, in the crystalline belt, in the northwestern part of the State. Lesser deposits occur in Towns, Lumpkin, Hall, Cherokee, Jackson, Walton, Morgan, Fulton, Meriwether, and Hancock counties.

The first successful attempt to mine asbestos in Georgia was by the Sall Mountain Company, in White county, in 1894. This company is in operation today. The Sall Mountain mines have the distinction of being the oldest mines producing asbestos in the United States at the present time.

There was only one producer of asbestos in Georgia in 1921, namely the Sall Mountain Company, 305 La Salle Street, Chicago, Ill., local address, Sautee, Georgia.

BARYTES

The barytes deposits of Georgia are practically confined to the Cartersville district, in Bartow county. There are also smaller deposits in Polk, Floyd, Bartow, Cherokee, Gordon, Murray, and Whitfield counties.

In 1887, the U. S. Geological Survey mentioned the occurrence of barytes in the Cartersville district. The first record of production was in 1901. From 1901 on there was a small yearly production but no statistics are available before 1914. The following table shows the crude barytes produced and marketed in Georgia, 1914-1920, in short tons.

Production of Barytes 1914-1920

Year	Quantity	Value	Year	Quantity	Value
1914	5,000	$	1917	111,300	$ 601,895
1915	31,027	102,825	1918	69,318	418,178
1916	104,784	401,295	1919	87,396	667,921
			1920	84,644	790,762

Barytes Producers in Georgia 1921

County	Name and Address of Operator	Location of Mine or Plant
Bartow	Bertha Mineral Co., 160 Front Street, New York, N. Y.	Cartersville, Ga.
Bartow	B. L. Ward, Comptroller, E. I. du Pont de Nemours Co., Wilmington, Del.	Cartersville, Ga.
Bartow	A. W. Belscher, Nulsen Corporation, Levee and Sidney Streets, St. Louis, Mo.	Cartersville, Ga.
Bartow	Holland W. Smith, Sec., Paga Mining Co., Cartersville, Ga.	Cartersville, Ga.
Bartow	W. J. Weiman, Mgr., Thompson, Weiman & Co., Room 709, 101 Park Ave., New York, N. Y.	Cartersville, Ga.

Bauxite

The bauxite of Georgia occurs in two distinct geographical locations, namely, in the Paleozoic rocks of Walker, Chattooga, Gordon, Bartow, Polk, and Floyd counties, in northwest Georgia, and in the Tertiary rocks in Wilkinson, Sumter, Macon, Schley, Webster, Stewart, and Randolph counties, in Central Georgia.

The first discovery of bauxite in America was in 1887, at Hermitage, a few miles northeast of Rome, in Floyd county, Georgia. The opening of this property in April, 1888, marked the beginning of bauxite mining in the United States. The Tertiary bauxite deposits in Wilkinson county were discovered in 1907 by Mr. Otto Veatch, Assistant State Geologist of Georgia.

Production of Bauxite in Georgia 1889-1912

GEORGIA			GEORGIA AND ALABAMA		
Year	Amount (long tons)	Value	Year	Amount (longs tons)	Value
1889	728	$ 2,666	1901	18,038	
1890	1,844	6,012	1902	22,677	
1891	3,301	a	1903	22,374	
1892	5,110	a	1904	21,913	
1893	2,415	a	1905	15,173	
1894	2,050	a	1906	25,065	
1895	3,756	a	1907	----------	
1896	7,313	a	1908	14,464	
1897	7,507	a	1909	22,227	
1898	25,149	75,437(b)	1910	33,096	
1899	15,736	a	1911	30,170	
1900	19,739		1912	19,587	(Ga. alone)

a—Value lumped with Alabama.
b—Georgia and Alabama.

Production of Bauxite for Georgia, Alabama, Tennessee 1913-1920

Year	Quantity (long tons)	Value	Year	Quantity (long tons)	Value
1913	40,370	$ 150,710	1917	62,134	$395,051
1914	24,071	92,508	1918	42,829	314,112
1915	28,245	144,345	1919	----------	----------
1916	49,190	284,810	1920 (Ga. alone)	34,397	309,187

Georgia remains second in rank in production of bauxite, Arkansas being first.

Bauxite Producers in Georgia in 1921

County	Name and Address of Operator	Location of Plant or Mine
Bartow	Kalbfleisch Corporation, 31 Union Square West, New York.	Hall's Station, Ga. (Lot 90).
Bartow	Republic Mining and Manufacturing Co., 1111 Harrison Bldg., Philadelphia, Pa.	Halls's Station, Ga.
Floyd	Republic Mining and Manufacturing Co., 1111 Harrison Bldg., Philadelphia, Pa.	Hermitage, Ga.
Floyd	Republic Mining and Manufacturing Co., 1111 Harrison Bldg., Philadelphia, Pa.	Vans Valley, Ga.
Macon	Minerals Products Corp., 2234 Dime Savings Bank Bldg., Detroit, Mich.	Oglethorpe, Ga.
Meriwether	Republic Mining and Manufacturing Co., 1111 Harrison Bldg., Philadelphia, Pa.	Warm Springs, Ga.
Randolph	Kalbfleisch Corporation, 31 Union Square West, New York.	Springvale, Ga.
Sumter	Kalbfleisch Corporation, 31 Union Square New York, N. Y.	Andersonville, Ga.
Sumter	Republic Mining and Manufacturing Co., 1111 Harrison Bldg., Philadelphia, Pa.	Andersonville, Ga.
Wilkinson	Republic Mining and Manufacturing Co., 1111 Harrison Bldg., Philadelphia, Pa.	Irwinton, Ga.

CEMENT

Both natural and Portland cement are produced in Georgia. The natural cement rock is found commercially in only two localities, namely, at Cement, Bartow county and at Rossville, Walker county. The raw materials, limestones and shells used for the manufacture of Portland cement are utilized at present only in Polk county in the vicinity of Rockmart.

Natural cement was manufactured in Georgia as early as 1851. The Portland cement industry began in Georgia in 1903.

Production of Natural Cement

Year	Quantity (in barrels)	Value	Year	Quantity (in barrels)	Value
1890	40,000	$ 40,000	1898	18,000	$13,500
1891	40,000	40,000	1899	13,000	9,750
1892	50,393	41,294	1900	28,000	21,000
1893	10,273	9,750	1901	50,577	40,967
1894	9,266	7,094	1902	55,535	31,444
1895	8,050	7,094	1903	80,620	44,402
1896	12,700	9,525	1904	66,500	37,750
1897	18,165	10,899	1905	89,167	51,040
			1906	180,500	89,075

No statistics are available from 1906 to the present. For some time past there has been no natural cement produced in Georgia.

The natural cement industry in the U. S. is now practically negligible. In 1907 there was produced in the United States about 750,000 barrels of natural cement as against 93,000,000 barrels of Portland cement. No statistics for Portland cement can be given because there have never been more than two producers in any one year in Georgia. The only company producing Portland Cement in Georgia in 1921 was the Southern States Portland Cement Company, located at Rockmart, Ga.

CHLORITE

Commercial deposits of Chlorite occur about five miles west of Canton, Cherokee county. In the past five years these deposits have been somewhat extensively worked but no statistics are available as there was only one producer, namely the American Mica Company.

CLAYS

Both Kaolin and fire-clay are found in all three of the major geological divisions of Georgia—the Coastal Plain, the Crystalline area, and the Paleozoic area. Commercially the most important clay deposits are those of the Fall Line, a narrow belt extending from Augusta

through Macon to Columbus. The following table gives the amount in short tons and the value of clay mined and sold in Georgia for the years 1905-1920.

Production of Clay 1905-1920

Year	Quantity	Value	Year	Quantity	Value
1905	29,028	$ 102,467	1913	156,374	$ 324,671
1906	38,979	156,690	1914	146,374	290,814
1907	47,737	147,242	1915	166,250	319,465
1908	37,916	106,028	1916	193,791	443,147
1909	38,320	159,606	1917	187,355	599,359
1910	66,292	223,785	1918	140,675	641,283
1911	68,161	223,262	1919	95,587	703,639
1912	75,815	244,953	1920	187,364	1,071,794

Clay Producers in Georgia in 1920

County	Name and Address of Operator	Location of Mine or Plant
Baldwin	Stevens Bros. & Co., Stevens Pottery, Ga.	Stevens, Pottery, Ga.
Richmond	Albion Kaolin Co., C. B. Lamar, Pres., Hephzibah, Ga.	Hephzibah, Ga.
Taylor	Golding Sons Co., Butler, Ga.	Butler, Ga.
Twiggs	American Clay Co., P. W. Martin, Pres., 33 W. 42nd St., New York, N. Y. Leased to Moore & Munger, 29 Broadway, New York.	Bernita, Ga.
Twiggs	Georgia Kaolin Co., E. Y. Mallory, Pres., Macon, Georgia.	Dry Branch, Ga.
Twiggs	R. H. Jones Co., Lessee, J. S. Epps, Prop. National Bank, Macon, Georgia.	Dry Branch, Ga.
Twiggs	John Sant & Sons Co., Thos. H. Sant, Sec., East Liverpool, Ohio.	Dry Branch, Ga.
Walker	Texmoga Clay Products Co., O. E. Deppen, Pres., Box 339, Chattanooga, Tenn.	Flintstone, Ga.
Walker	Georgia Refractories Co., Rossville, Ga.	Mission Ridge, Ga.
Wilkinson	Kaolin Mining Co., 404 Harrison Bldg.. 15th and Market Sts., Philadelphia, Pa.	Claymont, Ga.
Wilkinson	Columbia Kaolin & Aluminum Co., Westory Bldg., Washington, D. C.	Gordon, Ga.
Wilkinson	Savannah Kaolin Co., Savannah, Ga., or Wall St., New York, N. Y.	Gordon, Ga.
Wilkinson	Edgar Bros., Co., J. R. Edgar, Sec., Metuchen, N. J.	McIntyre, Ga.
Wilkinson	Akron Pigment Co.,	

COAL

The coal deposits of Georgia are confined to Lookout, Sand, and Pigeon mountains in extreme northwestern Georgia in Walker, Chat-

tooga, and Dade counties. All the commercial deposits are of bituminous coal and occur in the Lower and Upper Coal Measures of the Pennsylvanian rocks.

Previous to 1891, all the coal mined in Georgia was obtained from Dade county, near Cole City. The first mines operated in this district were opened by Gordon and Russell more than half a century ago.

The following table shows the production of coal in Georgia 1900-1918.

Coal Production in Georgia 1900-1918

Year	Short Tons	Value	Year	Short Tons	Value
1900	315,577	$370,022	1910	177,245	$259,122
1901	342,825	411,685	1911	165,210	246,208
1902	414,083	589,018	1912	227,503	338,426
1903	416,951	521,459	1913	255,626	361,319
1904	383,191	466,496	1914	140,243	239,462
1905	351,991	453,848	1915	134,496	231,861
1906	332,107	424,004	1916	173,554	310,093
1907	362,401	499,686	1917	119,028	301,393
1908	264,822	364,279	1918	66,716	234,377
1909	211,196	298,726			

COPPER

The most extensive copper deposits, so far located in the State, are to be found in Fannin, Cherokee, and Harrison counties. Those in Fannin county are located in the extreme northern part of the county only a short distance from the famous Ducktown copper mining district of Tennessee. The Cherokee copper deposits have been worked at only one place, namely the Canton copper mine, one mile south of Canton. The Waldrop copper mine in Haralson county is located about three miles northwest of Draketown, near the Haralson-Polk county line.

No copper is mined in Georgia at present.

CORUNDUM

The corundum deposits of Georgia occur in the Crystalline area in the counties of Rabun, Towns, Union, Lumpkin, Habersham, Hall, Cherokee, Cobb, Forsyth, Paulding, Douglas, Carroll, Troup, and Walton. The corundum belt, with a maximum width of 40 miles, runs in a general northeast-southwest direction through the above mentioned counties.

Corundum was first discovered on Laurel Creek, Rabun county, by an Englishman, named Thompson in the early seventies.

Dr. H. S. Lucas, of Chester, Massachusetts, purchased the original Laurel Creek property in 1880 and successfully operated it until 1892. Georgia has produced no corundum since 1893.

FULLER'S EARTH

Fuller's earth occurs in Georgia in three different geological formations, namely, the Alum Bluff formation of Miocene age and in the Midway and Jackson formations of Eocene age.

The fuller's earth deposits of the Alum Bluff formation occur in Decatur, Grady, Thomas, Lowndes, and Toombs counties. The deposits of the Jackson formation are found in Twiggs, Bleckley, Houston, Crawford, Wilkinson, Jones, Baldwin, Washington, Hancock, Jefferson, Burke, Richmond, and Columbia counties. The deposits of the Midway formation are located in Stewart, and Randolph counties.

Two fuller's earth plants are at present operated in Georgia, one at Attapulgus, Decatur county, operated by the Atlantic Refining Company and the other at Dry Branch, operated by the General Reduction Company.

GOLD

In a general way the gold region of Georgia covers the Piedmont Plateau and a portion of the Appalachian Mountains. In this broad area by far the larger portion of the auriferous deposits occur in narrow, well-defined belts running nearly parallel in a northeast-southwest direction. There are five such belts in the State, of which the Dahlonega belt has proved the most productive.

According to White's statistics of Georgia, gold was first discovered in the State on Duke's Creek, White county, in 1829. By 1838 the gold mining industry of the State had reached such proportions that the U. S. Government established a branch mint at Dahlonega. This mint continued in operation until 1861, and coined 1,381,784 pieces, valued at $6,115,569.

Value of Gold Mined in Georgia 1890-1921

Year	Quantity Fine Ounces	Value	Year	Quantity Fine Ounces	Value
1900	5,644	$ 116,700	1911	1,696	$35,070
1901	6,023	124,500	1912	694	14,360
1902	4,730	97,000	1913	730	15,108
1903	3,000	62,000	1914	787	16,270
1904	4,688	96,900	1915	1,732	35,821
1905	4,687	96,900	1916	1,090	22,539
1906	1,149	23,700	1917	333	6,889
1907	3,135	64,808	1918	285	5,893
1908	2,719	56,207	1919	37	767
1909	2,932	60,620	1920	35	732
1910	1,722	35,602	1921	.....	1,000 (approx.)

Owing to the decreased purchasing value of gold and the high cost of labor but little gold mining has been done in the State in the last few years.

GRANITES AND GNEISSES

The granites and gneisses of Georgia are widely distributed throughout the Piedmont Plateau but at present the granite quarrying is confined to a relatively few counties. The principal centers of the industry are at Stone Mountain, Lithonia, Elberton, Oglethorpe, Lexington, Sparta, Eatonton, Odessa, and Newnan.

Value of Georgia Granite Produced 1890-1920

Year	Value	Year	Value
1890	$ 752,481	1905	$ 971,207
1891	790,000	1906	792,315
1892	700,000	1907	858,603
1893	476,387	1908	970,832
1894	511,804	1909	843,542
1895	508,481	1910	1,049,186
1896	374,734	1911	847,023
1897	436,000	1912	823,207
1898	339,311	1913	906,470
1899	411,344	1914	958,831
1900	380,434	1915	660,454
1901	761,646	1916	813,068
1902	803,778	1917	568,143
1903	672,947	1918	558,296
1904	942,466	1919	885,663
		1920	934,182

Granite Producers in Georgia 1921

County	Name and Address of Operator	Location of Mine or Plant
DeKalb	Arabia Granite Co., 325 Connally Bldg., Atlanta.	Lithonia, Ga.
DeKalb	Combs Granite Co., Lithonia, Ga.	
DeKalb	Davidson Granite Co., J. K. Davidson, Lithonia, Ga.	
DeKalb	Johnson Granite Co., Lithonia, Ga.,	Lithonia, Ga.
DeKalb	J. H. Newber Co.	
DeKalb	E. W. Regan & Co., Lithonia, Ga.	
DeKalb	Stone Mt. Granite Corp., Stone Mountain, Ga.	Lithonia, Ga.
DeKalb	Wilson Chapman Granite Co., Box 114, Lithonia, Ga.	1 1-2 mi. N. of Lithonia, Ga.
Elbert	Peter Bertoni, Prop., Elberton Granite Works, Elberton, Ga.	
Elbert	D. Meritina, American Granite Co., Elberton, Ga.	
Elbert	G. L. Herndon, Elberton, Ga.	
Elbert	John H. Read, Elberton, Ga.	
Hancock	Georgia Quincy Granite Co., Macon, Georgia.	Sparta & Granite Hill, Ga.
Hancock	W. T. Macken Granite Works, Sparta, Georgia.	Sparta, Ga.
Rockdale	W. B. Parker, Box 65, Conyers, Ga.	
Stephens	Toccoa Rock Crushing Co., Toccoa, Georgia.	Cumahee, Ga.

GRAPHITE

Graphite is of rather wide-spread occurrence in a large number of the counties of the Piedmont Plateau. In most places, however, it is in limited quantitites. The most noted occurrences are in Bartow, Cobb, and Pickens counties. It is also known to occur in Cherokee, Douglas, Elbert, Hall, Heard, Madison, Rabun, Habersham, Spaulding, and other counties.

The mining of graphite, or more properly, the mining of graphitic schist, was begun in the Emerson district, Bartow county, by Joseph F. Allison, in 1892. About 1902 the American Graphite Company also began mining in the same district. These two plants have produced practically all the graphite for Georgia up to the present time.

The material mined has consisted of schist carrying from 2 to 15 per cent. of carbon and used chiefly as a filler and dryer for fertilizer. No statistics are available.

IRON ORES

The iron ores of Georgia are of two varieties, the Brown Iron ore and the Fossil Iron ore.

The Brown Iron ore has a wide distribution throughout the State, but the principal commercial deposits are confined to the Appalachian Valley and the Piedmont Plateau. The most extensive deposits of the Appalachian Valley, so far developed, occur in Polk, Bartow and Floyd counties. The deposits of the Piedmont Plateau have not been so extensively developed as those in the Appalachian Valley. Some of the most promising deposits in this section of the State are in Cherokee, Pickens, Gilmer, Fannin, and Meriwether counties.

The Fossil, or Clinton, ores of Georgia are confined to four counties: Dade, Walker, Catoosa, and Chattooga, in the extreme northwestern part of the State.

In addition to the two varieties of iron ore mentioned above, there also occur in various localities in the Crystalline area rather promising prospects of magnetic iron ore. Among these are the deposits near Union Point, Greene county; near Dahlonega, Lumpkin county; and near Draketown, Haralson county.

The following statistics give the production and value of the two types of iron ore together:

Production of Iron Ores 1900-1920

Year	Quantity, long tons	Value
1900	315,707	$ 447,127
1901	213,579	256,294
1902	334,054	464,335
1903	443,452	572,052
1904	293,802	358,438
1905	200,842	296,561
1906	411,230	734,780
1907	444,114	837,102
1908	321,060	540,189
1909	221,116	332,478
1910	313,878	482,659
1911	207,279	315,704
1912	135,337	227,282
1913	153,336	237,876
1914	66,222	119,363
1915	101,719	186,083
1916	252,143	413,259
1917	211,501	524,175
1918	262,003	878,612
1919	74,007	294,619
1920	164,482	460,633

Iron Ore Producers in Georgia 1920

Operator	Office	Mine	Location
Pulaski Iron Co.	Pulaski, Va.	Grady & Noble	Aragon, Ga.
		W. M. Baldwin	Cedartown, Ga.
		Long Property	Aragon, Ga.
Etowah Development Co.	Cartersville, Ga.	Iron Hill	Cartersville, Ga.
Cedartown Iron Co.	Anniston, Ala.	Green, Reed, Simpson	Cedartown, Ga.
Woodstock Operating Corp.	Anniston, Ala.	Grady	Cedartown, Ga.
		Woodstock 1	
		Woodstock 2	
		Woodstock 3	
		Etna	Prior, Ga.
		Menlo	Menlo, Ga.
M. Chester	Ellijay, Ga.	Cartecay	Ellijay, Ga.
So. Leasing Corp. B. C. Sloan, Sec.	Cartersville, Ga.	Bartow	Emerson, Ga. (Cartersville, Ga.)
Chattanooga Iron & Coal Corp.	90 West Street, New York, N. Y.	Estelle	Estelle, Ga.
Atlas Construction Co., (Mrs. Pauline S. Collier)	Chattanooga, Tenn.	Collier's (Taylor's Ridge)	Gore (Summerville, Ga.)
Telford Mfg. Co.	Rome, Ga.	Peters	Rome, Ga.
		Janet	Summerville, Ga.
LaFollette Coal & Iron Co.	LaFollette, Tenn.	Sugar Valley	Sugar Valley, Ga.

LIMESTONES

Limestones occur in three of the physiographical provinces of Georgia, namely, the Coastal Plain, the Piedmont Plateau, and the Appalachian Valley. In the Coastal Plain, limestones occur in many counties, but in only a few localities are they of economic importance. In general the limestones of the Piedmont area have been metamorphosed into marbles. The limestones of the Appalachian Valley, occurring in Polk, Floyd, Bartow, Chattooga, Gordon, Walker, Dade, Catoosa, Whitfield, and Murray counties, are the most abundant and of the greatest economic importance.

The history of the lime industry in Georgia dates back to the earliest settlers, for from very early times the value of burned lime for fertilizer and for the making of mortar has been known. The lime industry is still in its infancy in Georgia for it has only been in recent years, relatively speaking, that the true economic value of Georgia's limestones has been recognized.

Limestone Production in Georgia 1900-1920

Year	Value	Year	Value
1900	$ 54,451	1911	$ 31,632
1901	19,741	1912	53,187
1902	39,865	1913	83,899
1903	10,450	1914	89,216
1904	15,200	1915	86,254
1905	9,030	1916	82,799
1906	16,042	1917	155,172
1907	22,278	1918	192,515
1908	8,495	1919	213,698
1909	34,593	1920	325,407
1910	24,236		

Limestone Producers in Georgia 1920

County	Name and Address of Operator	Location of Quarry
Bartow	Lad Lime & Stone Co., Cartersville, Ga.	
Dade	Hooker Crushed Stone Co., Chattanooga, Tenn.	Hooker, Ga.
Polk	Empire Cement and Limestone Co., Cartersville, Ga.	

MANGANESE

The manganese ores occur in two distinct geological areas in Georgia: in the Paleozoic area, which includes the ten northwest counties of the State; and in the Crystalline area, which embraces the Piedmont Plateau and the Appalachian Mountain provinces.

The commercial mining of manganese ore apparently had its beginning immediately after the close of the Civil War. The first reported producing, amounting to 550 tons of the ore, was from the Cartersville district in 1866. One of the first mines operated in this district was in the Dobbins property which produced, between 1867 and 1885, 5,500 tons of manganese. About 1885, a number of mines were opened in Bartow, Polk, and Floyd counties, so that in 1887 Georgia ranked second among the States of the United States in the production of manganese.

Production of Manganese Ore in Georgia 1890-1920

ALL GRADES

Year	Quantity (long tons)	Value	Year	Quantity (long tons)	Value
1890	749	$ 4,920	1906		
1891	3,575		1907		
1892	826	5,782	1908		
1893	724	5,068	1909		
1894	1,277	8,620	1910		
1895	3,856	27,416	1911		
1896	4,085	27,032	1912		
1897	3,332	22,084	1913		
1898	6,689	41,571	1914		
1899	3,089	23,377	1915	3,844	$33,927
1900	3,447	26,816	1916		
1901	4,074	24,674	1917	16,895	208,256
1902	3,500	20,830	1918	17,455	241,598
1903	500	2,930	1919	3,774	
1904			1920	6,416	
1905	150	900			

Blank spaces represent no production.

Manganese Ore Producers in Georgia 1920

County	Name and Address of Operator	Location of Mine	Mine
Bartow	Republic Iron & Steel Co., W. J. Penhallegon, Gen. Supt. Birmingham, Ala.	Cartersville, Ga.	Dobbins Norris
Fannin	Cherokee Mining Co., E. L. Hertzog, Gen. Mgr., Spartanburg, S. C.	Blue Ridge, Ga.	McKinney

MARBLES

All of the marbles of Georgia, which have been worked up to date on a commercial scale, are confined to a narrow belt from one to three miles wide and sixty miles long in Fannin, Gilmer, Pickens, and Cherokee counties. The marble belt traverses these counties in a northeast-southwest direction.

The first systematic quarrying of marble in Georgia was done by Fritz T. Simmons in Longswamp Valley near Tate, Pickens county, in 1840. About two years later Simmons erected the first marble mill in Georgia. A short time later another mill was built by Simmons and Hurlick, two miles east of Jasper. The organization of the Georgia Marble Co., in May 1884, marked the beginning of Georgia as a great marble producing state.

Marble Production in Georgia 1900-1920

Year	Value	Year	Value
1900	$ 631,241	1911	$1,088,422
1901	936,549	1912	1,096,622
1902	660,517	1913	1,101,997
1903	565,605	1914	1,190,742
1904	690,714	1915	973,605
1905	774,550	1916	903,243
1906	919,359	1917	1,073,783
1907	864,281	1918	1,152,444
1908	916,281	1919	1,574,687
1909	766,449	1920	2,195,824
1910	953,917		

For many years Georgia has been second in the production of marble.

Marble Producers in Georgia 1921

County	Name and Address of Operator	Location of Quarry
Pickens	The Georgia Marble Co., Tate, Georgia.	Tate, Ga.
Pickens	North Georgia Marble Products Co.,	Whitestone, Ga.
Pickens	Willingham Stone Co.,	Whitestone, Ga.

MARLS

The marls of Georgia are confined to the Coastal Plain, where they are widely distributed. The best exposures are to be seen along the Chattahoochee, Flint, and Savannah rivers.

The chief use of the marls is for fertilizers, but the exact value of the Georgia material has never been adequately tested. The marl industry in Georgia is at present practically negligible.

MICA

The Georgia mica deposits are widely distributed throughout the Piedmont Plateau. Nearly every county in this part of the State has one or more prospects. Some of the most promising prospects in Cherokee county are in the vicinity of Holly Springs and Toonigh, about ten miles southeast of Canton. At a number of other scattered localities in Lumpkin, Union, and Upson counties commercial deposits occur. The main supply for the last few years has been from the county last named.

Production of Mica in Georgia 1915-1920

Year	Sheet Mica		Scrap Mica		Total
	Quantity short tons	Value	Quantity short tons	Value	Value
1915	2	$ 635			$ 635
1916	8	2,094			2,094
1917	15	12,142	26	$ 1,400	13,541
1918	104	77,300	40	2,750	80,050
1919	24	19,682	51	778	20,460
1920	25		101		16,707

Mica Producers in Georgia in 1919

County	Name and Address of Operator	Location of Mine
Upson	J. B. Barron, Thomaston, Ga.	Thomaston, Ga.
Upson	M. R. Brown, Thomaston, Ga.	Freeman & Brown Mica Mine, 3 mi. So. Thomaston, Ga.
Pickens	F. M. Cagle, Nelson, Ga.	7 mi. So., Jasper, Ga.
Rabun	H. E. Edwards, Clarkesville, Ga.	Kell Mine Near Clayton, Ga.
Upson & Monroe	John B. McDonald, Yatesville, Ga.	Marchman's & Persens Mines.

MINERAL WATERS

The mineral springs of Georgia are very widely distributed throughout the State. They are especially abundant in the Piedmont Plateau and the Appalachian Valley. The most noted springs are in the mountainous region of the Crystalline area where many of them have become sites of prominent summer resorts. Among the noted springs of Georgia are the following: Warm Springs and White Sulphur Springs, of Meriwether county; Bowden Lithia Springs, of Douglas county; Indian Springs, of Jackson county; White Sulphur Springs, of Hall county; White Path Springs, of Gilmer county; Porter Spring, of Lumpkin county; Catoosa Springs, of Catoosa county; Menlo Springs, of Chattooga county; and Cohutta Springs, of Murray county.

DIPLOMAS AWARDED THE STATE GEOLOGICAL SURVEY AT THE LOUISIANA-PURCHASE EXPOSITION, ST. LOUIS, 1904.

Production of Mineral Waters in Georgia 1890-1920

Year	Quantity Gallons	Value	Year	Quantity Gallons	Value
1890	66,000	$18,450	1906	130,900	$14,535
1891	81,500	27,300	1907	246,800	28,120
1892	114,000	30,450	1908	346,198	50,930
1893	86,000	14,600	1909	782,166	99,888
1894	36,000	8,100	1910	734,135	63,171
1895	54,000	10,400	1911	981,080	97,752
1896	167,550	26,855	1912	861,365	55,031
1897	175,500	41,300	1913	750,893	69,442
1898	197,100	39,230	1914	652,566	44,659
1899	128,040	24,770	1915	746,068	53,779
1900	148,500	28,200	1916	618,397	45,210
1901	284,976	45,521	1917	411,127	37,441
1902	419,100	60,797	1918	314,388	27,810
1903	379,517	65,252	1919	361,310	39,282
1904	305,294	45,744	1920	343,888	31,868
1905	270,249	37,619			

Mineral Water Producers in Georgia in 1920

County	Name and Address of Proprietor	Name of Spring
Bibb	White Oak Mineral Water Co., J. E. McDonald Bros., R. F. D. No. 1, Macon, Ga.	White Oak Mineral Wells.
Catoosa	Mrs T. A. Baldwin, R. F. D., No. 2, Tunnel Hill Ga.	Catoosa Springs
Chatham	Crystal Mineral Water Co., R. M. Demere, 305 Liberty Bank, Savannah, Ga.	Crystal Springs
Cobb	Benscot Mineral Springs Co., C. W. Lawshe, Austell, Ga.	Benscot Mineral Springs
Dodge	Eureka Spiings Corp., Inc., E. R. Pierce, Mgr., R. F. D. No. 2, Helena, Ga.	Eureka, Ga.
Douglas	Bowden Springs Co., H. C. Fairman, 94 Edgewood Ave., Litha Springs, Ga.	Bowden
Fulton	High Rock Mineral Water Co., J. E. McDonald Bros., R. F. D. No. 1, Macon, Ga.	White Oak Mineral Wells
Richmond	Windsor Springs, Augusta, Ga.	Windsor Springs

OCHER

The Ocher deposits of Georgia which are being worked on a commercial scale are located in the vicinity of Cartersville, Bartow county. The ocher occurs in a small belt which runs nearly north and south. The belt is about eighty miles long, with a maximum width of two miles.

The first authentic record of ocher mined in Bartow county, Georgia, dates back to 1877, at which date development work was started

near Cartersville by E. H. Woodward. In 1890 these holdings were purchased by the Georgia Peruvian Ocher Co. In 1898 the Cherokee Ocher and Barytes Company put a plant in operation. In 1899 the Blue Ridge Ocher Company established a plant and in 1902 the American Ocher Company established the fourth plant in the district.

Production of Ocher in Georgia 1890-1914

Year	Quantity (long tons)	Value	Year	Quantity (long tons)	Value
1890	800	$12,800	1903	5,212	$47,908
1891	600	9,000	1904	4,752	44,142
1892	1,748	26,800	1905	4,209	43,481
1893	2,600	39,000	1906	5,550	58,350
1894	1,690	17,840	1907	5,600	57,100
1895	2,105	31,080	1908	6,035	63,851
1896	2,981	28,005	1909	5,838	60,971
1897	2,608	36,600	1910	7,011	70,388
1898	2,858	30,798	1911	7,395	69,447
1899	3,212	39,505	1912	10,107	101,790
1900	6,828	73,172	1913	11,420	123,090
1901	5,077	49,176	1914	8,607	84,193
1902	3,688	38,423			

No statistics are available since 1914.

Ocher Producers in Georgia in 1921

County	Name and Address of Operator	Location of Mine or Plant
Bartow	Cherokee Ocher Co., Cartersville, Ga.	Cartersville, Ga.
Bartow	Georgia Peruvian Ocher Co., 165 Broawday New York, N. Y.	Cartersville, Ga.
Bartow	New Riverside Ocher Co., Cartersville, Ga.	Cartersville, Ga.

PYRITE

The pyrite deposits of Georgia appear to be confined wholly to the Piedmont Plateau. Throughout this area they are of rather widespread occurrence. The most important localities are in Lumpkin, Cherokee, Paulding, Cobb, Douglas, Haralson, Carroll, Towns, and Rabun counties.

The discovery and exploration of the Georgia pyrite deposits started with the development of gold mining, about 1830. No mining for pyrite itself was undertaken until the erection of the Georgia Chemical Company's pyrite-burning acid plant in the early eighties.

The first really successful pyrite mine in Georgia was the Villa Rica mine of the Sulphur Mining & Railroad Company, which was opened in 1899 and worked almost continuously until 1917. Since then a number of mines have been operated spasmodically.

Production of Pyrite in Georgia 1904-1918

Year	Quantity Tons	Value	Year	Quantity Tons	Value
1904	18,369	$76,101(a)	1913	11,110	$55,094
1905	19,928	71,863(a)	1914		
1906	26,173	78,817(a)	1915		
1907	28,281	85,307	1916		
1908	20,181	52,180	1917		
1909	15,848(a)	77,291(a)	1918	31,315	268,797
1910	148,653(b)	565,358(b)	1919		
1911			1920		
1912					

a—Georgia and Alabama.
b—Georgia and Virginia.

Within the last two years the output of pyrites has been negligible due to the importation of cheap sulphur from Louisiana. No mines are at present operated.

SAND AND GRAVEL

Sand and Gravel are both very largely distributed throughout the State, but are most abundant in the northern portion of the Coastal Plain. In the Piedmont Plateau and the Appalachian Valley the sands and gravels are for the most part along the streams, though scattered beds are found elsewhere in these areas.

Production of Sand and Gravel in Georgia 1904-1920

Year	Quantity Short Tons	Value	Year	Quantity Short Tons	Value
1904	88,381	38,362	1913	407,853	$166,798
1905	85,003	41,253	1914	260,425	80,130
1906	335,797	117,816	1915	572,309	191,447
1907	231,090	86,791	1916	483,615	126,799
1908	229,847	80,988	1917	380,154	138,182
1909	435,776	207,613	1918	270,071	121,655
1910	352,379	123,143	1919	362,487	181,844
1911	518,885	175,734	1920	375,052	231,858
1912	445,122	171,129			

Sand and Gravel Producers in Georgia 1920

County	Name and Address of Operator	Location
Bibb	Macon Fuel & Supply Co., Macon, Ga.	Macon, Ga.
Chatham	General Building Supply Co., Savannah, Ga.	Savannah, Ga.
Crawford	Atlanta Sand & Supply Co., Decatur and Grant Streets, Atlanta, Ga.	Rolls, Ga.
Crawford	J. L. Chevis, Prop., Allen Sand Co., Zenith, Ga.	Zenith, Ga.
DeKalb	Davidson Granite Co., Lithonia, Ga.	Lithonia, Ga.
Dougherty	Albany Lime & Cement Co.,	Albany, Ga.,
Floyd	N. G. Watson, Rome, Ga.	Rome, Ga.
Talbot	J. R. Hime Sand Co., Junction City, Ga.	Junction City, Ga.
Talbot	Kirkpatrick Sand & Cement Co.	Junction City Ga.
Taylor	O. O. Brown Sand, Co., Howard Ga.	Howard, Ga.
Taylor	Central of Georgia Sand Co., Howard Ga.	Howard, Ga.
Taylor	Kirkpatrick Sand & Cement Co.	Howard & Rabbit, Ga.
Taylor	W. C. Harkey Sand Co., R. F. D. No. 2, Mauk, Ga.	Mauk, Ga.
Telfair	Mrs. Annie H. Mobley, Lumber City, Ga.	Lumber City Ga.
Telfair	Lumber City Sand & Concrete Co., J. T. Wilbanks, Lumber City, Ga.	Lumber City Ga.
Whitfield	E. B. White Dalton, Ga.	Dalton, Ga.

SERPENTINE

The only deposit of serpentine which has so far been worked in Georgia occurs at the Verde Antique Marble Quarry in Cherokee county, about two miles southwest of Holly Springs.

Serpentine was first quarried here about 25 years ago by the American Marble Company. Later the quarry was leased for a term of fifty years to the Verde Antique Marble Company of Chicago, which company has operated it at irregular intervals. No production has been reported from the quarry for the last three or four years.

SLATE

The slate deposits of Georgia occur in Bartow, Polk, and Gordon counties. The largest area of slate begins about three miles south of Cartersville and extends roughly parrelled to the general southwest line of the Cartersville fault to a point about five miles south of Rockmart. Another slate deposit, belonging to the same formation, occurs in the vicinity of Cedartown. A third deposit, known as the Green Slate, belonging to a different formation, occurs in Bartow and Gordon counties. These slates are now being quarried and crushed for roofing purposes near Fairmont by the Richardson Company.

The first quarrying of Georgia slate was by Joseph G. Blanc, 1850. The descendants of Blanc held the properties until 1907, when they were sold to the Cherokee Slate Company. The slate quarries of Rockmart were worked from 1850 until 1861. They were later reopened about 1880.

The total production of slate in Georgia reported in the U. S. Geological Survey Mineral Resources Division from 1879 to 1917 was 38,097 squares, valued at $165,918.00. Since 1906, there have not been more than two producers in any year so that production can not be given.

In this connection attention is called to a fourth deposit of slate recently discovered in Bartow county. This slate is remarkable for its high potash contents, running from 8% to 10% potassium oxide (K_2O). Efforts have been made by one or more large companies to extract the potash from these slates for the use of commercial fertilizers but so far no successful commercial process has been devised.

TALC

The Georgia talc deposits occur at a large number of localities in the northern part of the State but commercial deposits have been developed at only a few places. The best properties are near Chatsworth, Murray county. A considerable amount of prospecting has also been done near Mineral Bluff, Fannin county. A small amount of talc has been mined near Ball Ground and Holly Springs, Cherokee county.

Talc has been mined at Fort and Cohutta Mountains, Chatsworth district for nearly 50 years.

Talc and Soapstone Production in Georgia 1890-1920

Year	Quantity Short Tons	Value	Year	Quantity Short Tons	Value
1900	6,477	$ 77,217	1913	3,309(a)	$ 35,416(a)
1901	693	4,717	1914	3,627(a)	57,927(a)
1903	1,012	9,042	1915	498	12,050
1907	739	11,473	1916	3,080	88,364
1908	455	7,261	1917	3,819	94,314
1909			1918	6,436(b)	80,260(b)
1910			1919	13,585(c)	170,608(c)
1911			1920	3,242(a)	64,754(a)
1912					

(a) Georgia and Massachusetts.
(b) Georgia, Maryland, Massachusetts.
(c) Georgia, Maryland, Massachusetts, Pennsylvania, Washington.

Only one talc mine was operated last year, namely, the Georgia Talc Company, Inc. The plant of this company is located at Chatsworth, Ga.

COKE

Closely related to mineral production is the production of Beehive coke. Only one company is now engaged in Georgia in the making of Coke, namely the Durham Coal and Iron Company. The plant is located at Chickamauga, Georgia.

Production of Beehive Coke 1900-1918

Year	Quantity Short Tons	Value	Year	Quantity Short Tons	Value
1900	73,928	$ 210,646	1910	43,814	$ 173,049
1901	54,550	154,625	1911	37,553	135,190
1902	82,064	298,963	1912	43,158	161,842
1903	85,546	368,351	1913	42,747	186,304
1904	75,812	212,697	1914	24,517	100,529
1905	70,593	224,260	1915	20,039	81,170
1906	70,280	277,921	1916	47,127	232,630
1907	74,924	315,371	1917	39,589	322,175
1908	39,422	137,524	1918	22,048	193,317
1909	46,385	159,334			

SUMMARY

The following is a summary of the value of mineral products of Georgia in 1920, collected in cooperation with the U. S. Geological Survey.

Value of Mineral Products of Georgia 1920

Asbestos, Cement and Coal	$ 769,616
Barytes	790,362
Bauxite	309,187
Brick and Tile	5,425,000
Clay	1,070,738
Coke, Gold and Lime	215,312
Fuller's Earth and Manganese	215,663
Granite	934,182
Iron Ore	460,633
Limestone	325,407
Marble	2,195,824
Mineral Waters	31,868
Misc. Stone, Ocher, Peat (estimated)	287,503
Mica	13,707
Pottery	24,390
Pyrite, Sand-Lime Brick, and Talc	105,307
Sand and Gravel	231,858
Total	$13,406,557

WATER POWERS

The report on water powers of Georgia recently issued by the State Geological Survey in co-operation with the U. S. Geological Survey, shows the net 10-hour horse power at low water to be 1,743,650 H. P. and a safe average daily 10-hour horse power to be 2,281,800 H. P.

The same report shows that up to 1920 there had been developed 262,148 continuous horse power (24 hours) as shown by the installed wheel power capacity. Rating the value of a horse power at $40 per annum, Georgia's water power based on the water wheel capacity now developed is worth $9,506,000 annually.

NOTES ON THE GEOLOGY OF GEORGIA[1]

ARCHEAN SYSTEM

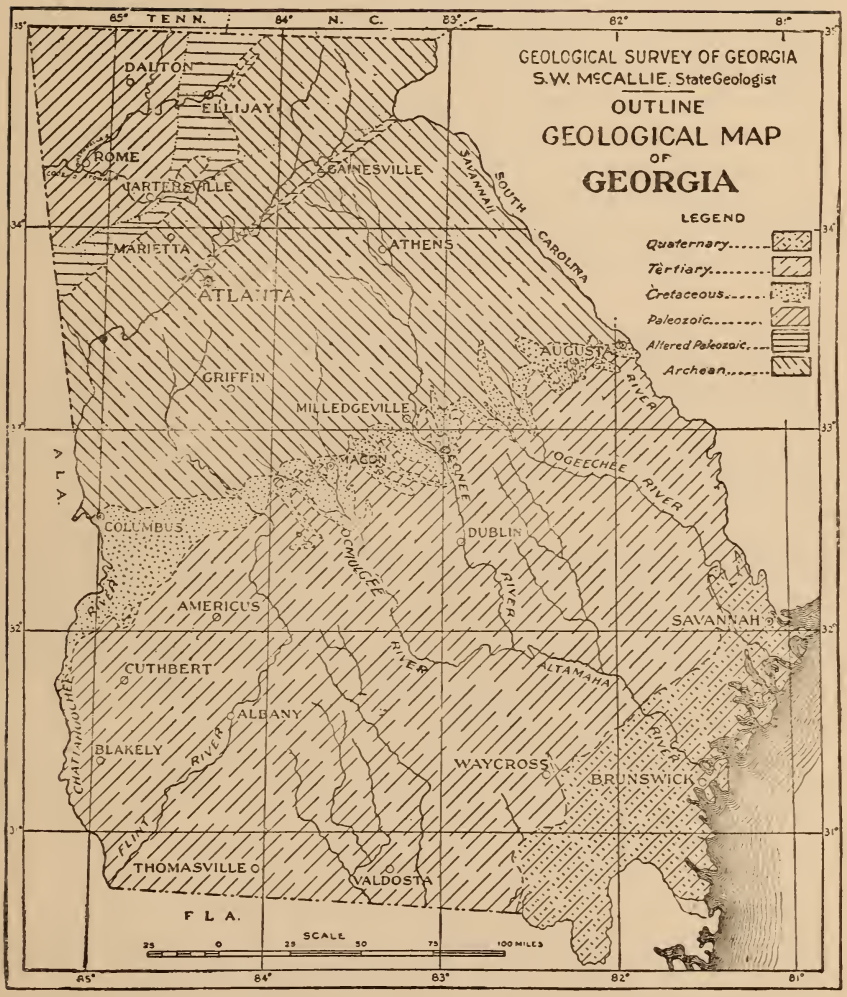
The geological history of Georgia begins with the ancient Crystalline rocks, the greater part of which are supposed to be of Archean age. These rocks form a northeast-southwest belt about 125 miles wide traversing the northern part of the state and are a part of the great belt of ancient Crystallines extending from northeastern New York to eastern Alabama (Fig. 1). The areal extent in Georgia is about 15,000 square miles, or approximately one-fourth of the state. They occupy all of the physiographic division known as the Piedmont Plateau, and a part of the Appalachian Mountain division. To the northwest they are limited by the metamorphic Cambrian rocks and to the south by the Cretaceous and by the Tertiary. The latter boundary is sharp and distinct, while the former is ill-defined. These rocks are here described under the following names: Carolina gneiss, Roan gneiss, and granites.

The Carolina gneiss, so called from its wide distribution in the Carolinas, where it has been studied by Keith and others, is the prevailing rock of the ancient Crystallines of Georgia (Fig. 2). Broadly speaking, the formation may be correlated with the Baltimore gneisses of Maryland and the Stanford and Fordham gneisses of New York.

The most abundant, widespread, and typical rocks of the Carolina formation are schists, largely micaceous and garnetiferous, and biotite gneiss. In addition there occur in more or less restricted areas graphitic schist, quartzitic schist, and schistose conglomerate. The most persistent character of these rocks is the schistose and banded structure due to the segregation of the component minerals along definite lines. They are the oldest rocks of the state and may be considered the country rock into which the Roan gneiss and granites have been intruded. The series is supposed to be largely of igneous origin, though sediments undoubtedly occur in certain localities, as shown by the graphitic schist, quartzitic schist, and schistose conglomerate.

[1]By S. W. McCallie, State Geologist.

DIPLOMAS AWARDED THE STATE GEOLOGICAL SURVEY AT THE LOUISIANA-PURCHASE EXPOSITION, ST. LOUIS, 1904.


GEOLOGICAL SURVEY OF GEORGIA
S.W. McCALLIE, State Geologist
OUTLINE
GEOLOGICAL MAP
OF
GEORGIA
LEGEND
Quaternary
Tertiary
Cretaceous
Paleozoic
Altered Paleozoic
Archean
TENN.
N. C.
S. C.
DALTON
ELLIJAY
ROME
CARTERSVILLE
GAINESVILLE
MARIETTA
ATHENS
ATLANTA
GRIFFIN
MILLEDGEVILLE
AUGUSTA
MACON
COLUMBUS
DUBLIN
AMERICUS
SAVANNAH
CUTHBERT
ALBANY
BLAKELY
WAYCROSS
BRUNSWICK
THOMASVILLE
VALDOSTA
FLA.
ALA.
SAVANNAH RIVER
SOUTH CAROLINA
OGEECHEE RIVER
ALTAMAHA RIVER
OCMULGEE RIVER
FLINT RIVER
CHATTAHOOCHEE RIVER
SCALE
25 0 25 50 75 100 MILES

The Roan gneiss is a series of basic igneous rocks including hornblende schist, hornblende gneiss, and schistose diorite. These rocks occur in belts varying from a few feet to hundreds of rods in width and often cut the Carolina gneiss, into which they have been intruded at rather high angles. Less abundant and only locally developed are pyroxenites, dunites, and serpentine belonging to the same series.

The granites are widely distributed and in places cover areas of many square miles. They are prevailingly biotic and generally show gneissic structure. In age they are supposed to be largely pre-Cambrian, though the more massive varieties, such as Stone Mountain near Atlanta, are probably younger. The granites unquestionably represent two or more periods of intrusion.

CAMBRIAN SYSTEM

ALTERED CAMBRIAN

The Cambrian system is divided into the altered and unaltered Cambrian. The altered or metamorphic Cambrian rocks, so far as known, are mainly confined to an irregular belt, varying in width from eight to twenty-five miles, in the northwestern part of the state. The belt lies immediately west of the Archean rocks and embraces in its northern extension a greater part of the Appalachian Mountain physiographic division of the State. These rocks belong to the Ocoee group of Safford and were long regarded as of Algonkian age. However, fossils of Lower Cambrian age are found as far down as the middle of this group of strata in Tennessee and North Carolina, and the strata below the fossil-bearing beds are comformable and not materially different in character. In addition to this main belt there is a narrow belt known as the Brevard schist entering the state from South Carolina northeast of Gainesville and stopping about five miles west of Atlanta. It seems quite probable that the metamorphic Cambrian originally overlay the Crystallines as far east as Atlanta and possibly beyond.

This group of altered sediments has been studied in detail only in one section of the state, namely the area covered by the *Ellijay Folio.* In that locality the rocks have been described by La Forge and Phalen under the following formation names: (1) Great Smoky formation, (2) Nantahala slate, (3) Tusquitee quartzite, (4) Brasstown schist, (5) Valleytown formation, (6) Murphy marble, (7) Andrews schist, and (8) Nottely quartzite.

The *Great Smoky formation,* in the Ellijay quadrangle along its eastern margin, lies upon the Carolina gneiss, although the imme-

diate contact is difficult to define, as in that section the latter is made up largely of graywacke and conglomerate, which are very similar in lithological character to the base of the Great Smoky. The formation consists of a great thickness of conglomerate, graywacke, sandstone, quartzite, slate, mica schist, garnet schist, and staurolite schist. The conglomeratic phase is best developed to the east and north, while to the west and south the mica schist, quartzite schist, and slates prevail. The Great Smoky formation is a part of Safford's Ocoee series and has been provisionally correlated with the Cochran and the Thunderhead conglomerates of Tennessee and North Carolina. West of the Ellijay quadrangle and below the Great Smoky formation occur considerable areas of the Wilhite slate and the Gilmer formation, but their detailed structure and relations have not yet been worked out.

The *Nantahala slate,* near the Georgia-North Carolina line, includes principally blackish and dark-gray slates, though white quartzite and staurolitic schist are also more or less plentiful. Farther south in the vicinity of Ellijay and beyond, the formation is mainly graphitic schist with but few siliceous beds. Its distribution is confined to the eastern margin of the metamorphic area, where it forms narrow belts rarely over a mile in width.

The *Tusquitee quartzite,* which is apparently confined to the Ellijay quadrangle, consists almost entirely of white quartzite with an occasional bed of conglomerate. Owing to the persistent character of the formation and its difference in color from the associated rock, it is an excellent guide in working out the stratigraphy of the region, which is much complicated by numerous faults and folds.

The *Brasstown schist,* where not displaced by faulting, has a similar distribution to the Tusquitee quartz, though it does not extend so far south as the latter. It is made up of banded slate and ottrelite schist having usually a dark, bluish color. Owing to its limited distribution it is only of minor stratigraphic importance.

The *Valleytown formation* consists of biotite schists, sericite schist, and mica gneiss, with a few beds of quartzite and conglomerate. In the Ellijay quadrangle south of Cherrylog it is described as a nearly homogeneous mass of sericite, mica schist, and siliceous slate, with some talcose material. The occurrence of graphitic schist beds are noted in the formation between Toccoa River and Ellijay. The formation is usually valley-forming, though north of Blue Ridge, extending to the state line, it forms a rather prominent ridge, as well as the narrow valleys on either side.

COLUMNAR SECTION

ALTERED PALEOZOIC AND ARCHEAN ROCKS OF GEORGIA

SYSTEM	FORMATION	COLUMNAR SECTION	THICKNESS IN FEET
METAMORPHIC CAMBRIAN	NOTTELY QUARTZITE		200 +
	ANDREWS SCHIST		50
	MURPHY MARBLE		50-300
	VALLEYTOWN FORMATION		1200-2000
	BRASSTOWN SCHIST		1200-1500
	TUSQUITEE QUARTZITE		20-600
	NANTAHALA SLATE		1000-2000
	GREAT SMOKY FORMATION		5000-6500
	UNCONFORMITY		
ARCHEAN	GRANITE		
	PYROXENITE, DUNITE, AND SERPENTINE		
	ROAN GNEISS		
	CAROLINA GNEISS		

The *Murphy marble,* from an economic standpoint, is the most important of the metamorphic group of rocks in the state. It consists of holocrystalline limestone which in places becomes magnesian. The magnesian phase of the formation is commonly fine-grained, while the high-calcium phase is coarse-grained. It is usually white but in places is more or less banded or mottled with black owing to the presence of graphite. The formation enters the state from North Carolina in the vicinity of Culberson, from which point it continues southwest in one or more narrow belts, with a few interruptions due to faulting, to a point a few miles beyond Tate, Pickens County, the seat of Georgia's great marble industry. Marble very similar in texture and composition occurs many miles farther to the southwest in Haralson County, near Buchanan, which is supposed to be the southern extension of the Murphy marble. The formation is probably the equivalent of the Shady limestone, an unaltered magnesian limestone hereafter to be described.

The *Andrews schist* is a comparatively thin, unimportant calcareous schist overlying the Murphy marble near the Georgia-North Carolina line, and like the overlying Notterly quartzite is of very limited extent. It is made up almost entirely of dense quartzite which is highly resistant to weathering and is therefore ridge-forming.

UNALTERED CAMBRIAN

The Unaltered Cambrian rocks occupy the northwestern part of the state and are divided into the Lower, the Middle, and the Upper divisions, the first named being subdivided into the Weisner quartzite, Shady limestone, Cartersville formation, Apison shale, and Rome formation (Fig. 3).

The *Weisner quartzite,* which is the southern extension of a part of the Chilhowee sandstone of Tennessee, forms a prominent series of ridges and hills along the eastern margin of the Appalachian Valley as far south as Cartersville and a few miles beyond. At this point it is cut out by the Cartersville fault, but farther to the southwest it again appears in a small area near Esom Hills, where it forms the northern extension of a large area just across the state line in Alabama. The lithological character of the Weisner quartzite as described by Hayes is fine-grained and vitreous, though the formation also contains some beds of fine conglomerate and considerable siliceous shale. A few imperfectly preserved fossil remains, including brachiopods, corals, and worm tubes, all supposed to be Lower Cambrian, have been found in the formation in the vicinity of Cartersville and Emerson.

The *Shady limestone* lies immediately above the Weisner quartzite, and it has a like distribution. The formation consists chiefly of gray magnesian limestone usually massive but in places shady and siliceous. It is of very great economic importance, as associated with its weathered product, occur more or less extensive deposits of barytes, iron ore and manganese ore. Fossils are almost entirely absent, though in the vicinity of Cartersville a fossil sponge, a lower Cambrian form, has been found.

The *Cartersville formation,* as recently defined by Shearer, is known only in the Cartersville district. It is supposed to occupy the same position in the stratigraphic column as the Watauga shale of Tennessee and the Apison shales of Tennessee and Georgia. The formation has a limited distribution, being confined to one main belt less than twenty miles long. It consists mainly of highly aluminous shales, which are remarkable for their high potash contents, often as much as 10 per cent K_2O. Associated with the shales, which are chiefly of a gray or purplish color, there are often found thin layers of feldspathic sandstone and quartzite, but these form only a minor part of the formation as a whole.

The *Apison shale* consists of varicolored argillaceous shales developed only in limited, elongated areas in Whitfield and Catoosa counties. Although the Apison is evidently approximately equivalent to the Cartersville formation in age, the exposures are in the western part of the valley.

The *Rome formation* consists of sandstone and shale and is confined to two belts near the center of the Appalachian Valley. The main belt, which is rarely more than two miles wide, extends from near Cave Spring, Floyd County, northeast through Rome, to a point within about three miles northwest of Calhoun in Gordon County. The other belt commences near Villanow in Walker County and continues to the Georgia-Tennessee line a few miles northeast of Ringgold. A third belt which Hayes placed in this formation on the basis of stratigraphic position is above described as the Cartersville formation. Immediately overlying the Rome formation and apparently without any stratigraphic break are the only representative of Upper Cambrian, namely the Conasauga formation and the lower division of the Knox dolomite formation.

The *Conasauga formation,* with the exception of the Knox dolomite, covers the largest surface of any of the Cambrian series of Georgia. It is especially well developed along the eastern side of the Appalachian Valley, where it occurs in two main elongated but

broad belts. The easternmost of these belts continues south from the Georgia-Tennessee line from Tennga to a point a few miles south of Cartersville, where it is cut off by the Cartersville fault, while the other belt, after being divided into minor belts and at points uniting with the easternmost belt, continues to the Alabama state line by way of Rome. Farther to the west are three narrow belts, one of which, lying to the west, traverses the entire northwestern corner of the state by way of Lafayette. The upper part of the formation is made up largely of olive-green and yellowish-green argillaceous shale, but the lower part consists mainly of grayish and bluish limestones locally oölitic and interstratified with the shale. The Conasauga formation contains an abundant Cambrian fauna which has been studied by Professor C. D. Walcott.

The *Knox dolomite* is divided by an unconformity into a lower and upper division. The upper division on paleontological evidence has been referred to the Ordovician system and the lower to the Cambrian. The formation as a whole consists of a great thickness of magnesian limestones with much chert in places. It occurs in a large number of broad and narrow belts traversing the Appalachian Valley.

ORDOVICIAN SYSTEM

The *Chickamauga formation* represents both the Middle and the Upper group of the Ordovician system. It consists of sediments laid down in two separate basins. The rocks in the western part of the valley consist of interbedded limestones and shales outcropping in a number of long, narrow belts, while in the eastern part of of the valley the formation is divided into the Chickamauga limestone and the Rockmart slate. The latter consists chiefly of dark-colored slates, with a few thin beds of sandstone and some limestone usually high in calcium.

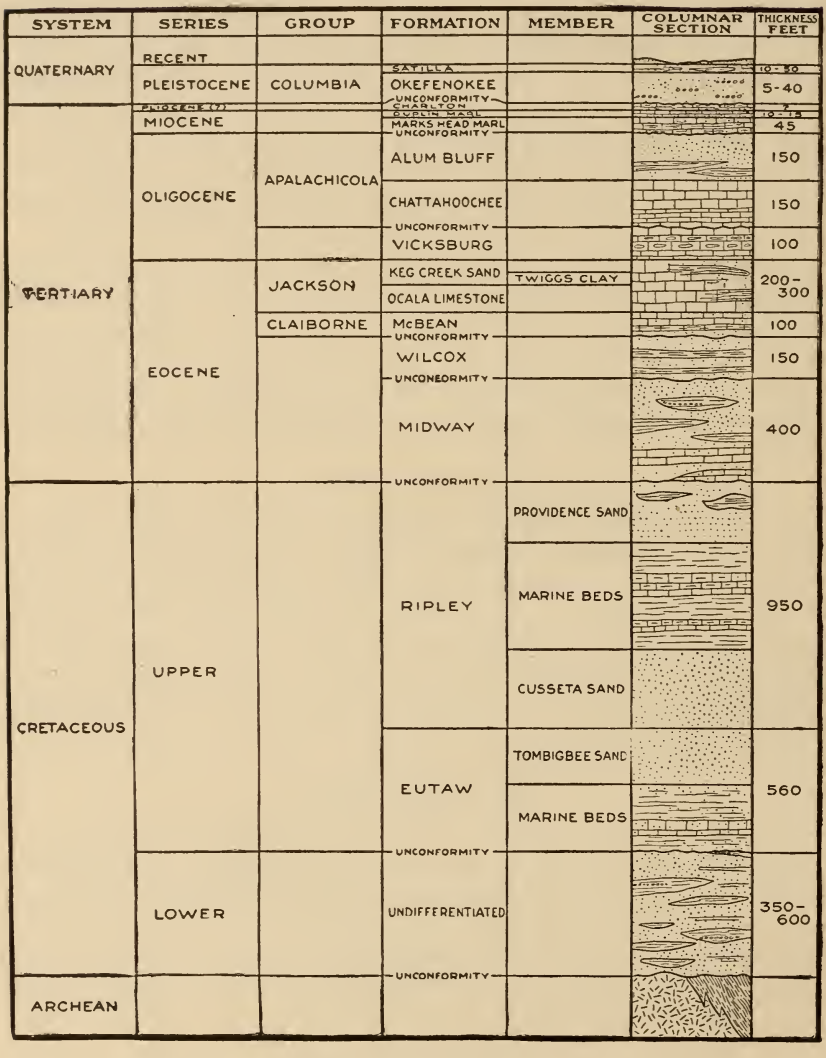
SILURIAN SYSTEM

The *Rockwood formation,* which uncomformably overlies the Chickamauga formation, is the only representative of the Silurian system. It consists of olive-green shales and thin-bedded sandstone, with one or more beds of fossiliferous iron ores. It occurs only in the western part of the Appalachian Valley, where it forms narrow belts at the base of the higher ridges and mountains capped with Carboniferous rock.

DEVONIAN SYSTEM

The *Chattanooga black shale* and the *Armuchee chert* are the only representatives of the Devonian system in Georgia. These two

COLUMNAR SECTION
COASTAL PLAIN OF GEORGIA



formations are separated from each other by an uncomformity and are supposed to represent the Upper and Lower Devonian respectively, the middle part of the system being absent. The black shale, which attains a thickness of not more than twenty feet, is confined to the western part of the valley, where it occurs in narrow outcrops with a linear distribution coextensive with the Rockwood formation. The Armuchee chert, which consists of bedded chert and thin beds of reddish-brown sandstone, is confined to a few small areas north of Rome.

CARBONIFEROUS SYSTEM

The *Fort Payne chert* is the lowest member of the Mississippian group of the Carboniferous system and uncomformably overlies the Chattanooga black shale. It consists essentially of siliceous limestone, with layers and nodules of chert made up in places largely of crinoid stems. The formation in the western part of the Appalachian Valley occupies narrow belts, while north of Rome it covers large, irregular areas.

The *Floyd shale* and the *Bangor limestone,* which also belong to the Mississippian group are probably stratigraphically equivalent, though one is largely shale and the other limestone. The former is best developed along the narrow valleys at the base of Lookout and Sand mountains, while the other occurs in numerous narrow belts in Floyd County and the adjacent counties both north and east of Rome.

The *Pennington shale* unconformably overlies the Bangor limestone and forms the uppermost series of the Mississippian group. It consists largely of shale, with sandstone in the upper portion. Its linear distribution is coextensive with the Bangor limestone.

The *Lookout formation* and the *Walden sandstone* are both members of the Pennsylvanian group. They are best developed in Lookout and Sand mountains, which constitute what is known as the Cumberland Plateau physiographic division of the state. They consist of sandstones, conglomerates, shales, and a number of commercial coal seams.

CRETACEOUS SYSTEM

The Cretaceous system, which rests unconformably on the old crystalline rocks, is confined to a narrow, irregular belt traversing the middle portion of the state in a southwest direction from Augusta to Columbus by Milledgeville and Macon. The total area covered by this system of rocks is approximately 250 square miles. It is

divided into an upper and a lower series, the latter being further divided into two formations, namely the Ripley and the Eutaw (Fig. 4).

The *Lower Cretaceous,* so far undifferentiated, lies immediately upon the crystalline rocks below and is uncomformably overlain by the Eutaw. The basal unconformity represents an enormous time interval, including all Paleozoic time and the Triassic[1] and Jurassic periods of the Mesozoic time. The formation is made up predominantly of coarse-grained cross-bedded, arkosic sand, with a subordinate amount of white clays in the form of lenses. It forms an irregular belt varying from two to ten miles in width and extending entirely across the state.

The *Eutaw and Ripley formations,* each divided into two or more members, occupy an elongated area immediately south of the Lower Cretaceous between the Ocmulgee and Chattahoochee rivers. Both formations are of marine origin and consist mainly of calcareous, micaceous sand and dark-gray sandy clay, with some thin-bedded impure limestone. The upper member of the Ripley formation is unconformably overlain by the Midway formation, the basal member of the Eocene series.

TERTIARY SYSTEM

The Tertiary system of rocks has a far greater areal extent than any other system in the state. With the exception of a narrow belt of Quarternary along the Atlantic seaboard and narrow irregular belts of Cretaceous immediately south of the ancient Crystallines, it covers the entire Coastal Plain which comprises more than one-half the area of the State. The system is represented by the following series: the Eocene, the Oligocene, the Miocene, and the Pliocene. The first named is divided into five formations, the Midway, the Wilcox, the McBean, the Ocala, and the Keg Creek. The Keg Creek and the Ocala limestone formations both belong to the Jackson group, while the McBean formation belongs to the Claiborne group.

EOCENE SERIES

The *Midway formation,* which forms the base of the Eocene series, lies unconformably upon the upper member of the Cretaceous and is unconformably overlain by the Wilcox. It consists of sand, clay, and marl, and forms a narrow northeast-southwest belt extending from Fort Gaines on the Chattahoochee River to a point a short

[1]The Triassic rocks in Georgia are represented by diabase dikes which are widely distributed over the Piedmont Plateau.

COLUMNAR SECTION
PALEOZOIC ROCKS OF GEORGIA

ERA OR SYSTEM	PERIOD OR GROUP	FORMATION	COLUMNAR SECTION	THICKNESS IN FEET
CARBONIFEROUS	PENNSYLVANIAN	WALDEN SANDSTONE		930
		LOOKOUT FORMATION		500
	MISSISSIPPIAN	PENNINGTON SHALE		780 +
		BANGOR LIMESTONE — PROBABLY TIME EQUIVALENTS		900
		FLOYD FORMATION — PROBABLY TIME EQUIVALENTS		1,500 +
		FORT PAYNE CHERT		200
DEVONIAN	UPPER	CHATTANOOGA BLACK SHALE		20
	MIDDLE (ABSENT) / LOWER	FROG MOUNTAIN SANDSTONE AND ARMUCHEE CHERT		40
SILURIAN	UPPER (ABSENT) / MIDDLE NIAGARAN / LOWER (ABSENT)	ROCKWOOD FORMATION		1,600
ORDOVICIAN	UPPER	(WESTERN BASIN) CHICKAMAUGA FORMATION — (EASTERN BASIN) ROCKMART SLATE		2,500 +
	MIDDLE	CHICKAMAUGA LIMESTONE		200
	LOWER	KNOX DOLOMITE		5,000
CAMBRIAN	UPPER CAMBRIAN OR SARATOGAN / MIDDLE CAMBRIAN OR ACADIAN	CONASAUGA SHALE AND LIMESTONE		2,000
	LOWER CAMBRIAN OR GEORGIAN	ROME FORMATION		3,500
		APISON SHALE		1,000
		CARTERSVILLE FORMATION		1,000
		SHADY LIMESTONE		1,100 +
		WEISNER QUARTZITE		2,500 +

distance east of Flint River in Houston County. At no place does it exceed twelve miles in width.

The *Wilcox formation* has a distribution similar to the Midway, though it probably does not extend beyond Flint River. It is made up mainly of sandy, glauconitic shell marl and laminated, sandy, dark-colored lignitic clay. Near Flint River pure beds of white clay occur, with red and varicolored sand.

The *McBean formation* forms an extremely irregular belt which varies from two to thirty miles or more in width and extends entirely across the state. East of Ocmulgee River it rests unconformably on the strata of Lower Cretaceous age, while between Flint and Chattahoochee rivers it rests unconformably upon the Wilcox formation. It consists of shell marl, sandy limestone, glauconitic, calcareous sands, and clays in the form of fuller's earth.

The *Ocala limestone,* which is best developed between Ocmulgee and Chattahoochee rivers, is the main representative of the Jackson group in Georgia. Its eastern boundary lies usually a few miles west of Flint River, whence it extends south and west as a broad belt to the Georgia-Alabama-Florida state line, with an average width of more than thirty-five miles. The formation, as the name suggests, is made up of limestone with more or less chert in places.

OLIGOCENE SERIES

The *Oligocene series* is represented by the Vicksburg, the Chattahoochee, and the Alum Bluff formations, subdivisions of the Appalachicola group. The three formations are confined largely to the southern part of the Coastal Plain near the Georgia-Florida state line and to irregular areas southeast and southwest of Macon. The Vicksburg and the Chattahoochee formations, which are separated by an unconformity, consist largely of limestone, while the Alum Bluff formation is made up mainly of sands and clays.

MIOCENE SERIES

The *Marks Head Marl* and the *Duplin marl* are the only formations belonging to the Miocene series. These two formations, which are best developed at Porters Landing on Savannah River, consist mainly of marls, sands, and clays. The Marks Head marl unconformably overlies the Alum Bluff formation.

PLIOCENE SERIES

The *Charlton formation,* which is supposed to belong to the Pliocene series, occurs along St. Marys and Satilla rivers in the extreme

southern part of the state. The formation consists mainly of shell marls.

The *Altamaha (Lafayette?) formation,* not shown in the columnar section, has the greatest areal extent of any formation in the Coastal Plain, covering approximately 21,000 square miles. Like the underlying Charlton formation, it is supposed to be Pliocene. The formation has a maximum thickness of less than three hundred feet and consists chiefly of sand, gravel, and clay, which in places become indurated. With the exception of a few fragments of wood it is entirely free from organic remains.

QUATERNARY SYSTEM

PLEISTOCENE SERIES

The Pleistocene is represented by the Okefenokee and the Satilla formations, divisions of the Columbia group. These formations form a belt along the Atlantic Coast, with a width from twenty to fifty miles. The Okefenokee consists chiefly of gray sand, and the Satilla is made up of greenish and bluish marine clays and gray and yellow sands.

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In the case of nearly every reference given all footnotes and bibliographies were reviewed for further references, so that the writer feels that the list of references is largely complete.

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APPENDIX[1]

THE PITTS METEORITE

The fall of the Pitts metorite here described was one of the most interesting phenomena of its kind heretofore observed within the limits of the state. The meteorite which fell near Forsyth, Georgia, May 8, 1828 and described by White in his "Statistics of Georgia," was probably of larger size but it was not witnessed by so many people nor did the attendant phenomena seem to be so impressive.

The Pitts meteorite fell in a negro settlement in the western part of Wilcox County near the town of Pitts about 9 o'clock (eastern time), April 20, 1921. No clouds were in view and the sun was shining brightly. It was seen as far north as Sunny Side in Henry County, 36 miles south of Atlanta, and as far south as Moultrie in Colquitt County.

In addition to the above towns that appear to mark the north and south limits of its visability it was also seen at Camilla, Albany, Sewell, Cordele, Hawkinsville, Perry, Macon, and Alma. It was no doubt plainly visible over an area of several thousand square miles and could have been distinctly seen by fully a quarter of a million people had they been looking in the proper direction.

My attention was first called to the occurrence by press notices on the 21st of April and on the 22nd I received a specimen of the meteorite from Col. W. H. Dorris, of Cordele, accompanied by a short description of the phenomena. On April 24th I visited Pitts with a view to securing at first hand all the data possible concerning the exact locality, the attending phenomena, etc. Mr. A. C. Shell and other citizens of the town rendered me invaluable service in securing the information desired and also obtained for me for examination and study all of the fragments of the meteorite except one, which specimen was later secured from the owner by personal request from Governor Dorsey. Several hours were spent in the vicinity of the fall interviewing eye witnesses of the phenomena and in making a diagram showing the relative positions at which the fragments struck the ground.

THE PHENOMENA

The attendant phenomena witnessed by the observers of the Pitts meteorite were similar in character and succeeded each other in the

[1]Written by S. W. McCallie, State Geologist.

same order as that noted in meteorite falls in general. Named in order of their occurrence they were, (1) A rapid moving body often referred to as a fire ball; (2) A dense smoke in the wake of the fire ball occasionally luminous for several minutes; (3) Distinct boomings generally compared to discharge of distant cannon, succeeded by a number of lesser sounds; (4) a roaring or whizzing noise not unlike the sound of a falling body; (5) The falling of dark body and its impact on the surface of the earth.

The rapid moving fire ball was the first phenomena that attracted the attention of the observers of the Pitts meteorite. It was described by witnesses at Albany as a rapidly moving body about the size of a man's head appearing in the sky in a northeasterly direction. At Moultrie it was referred to as a brilliant body moving downward in zig-zag course looking as if it might fall in the northern part of the city. At Sunny Side, more than a hundred miles from the place where the meteorite fell, it was seen in a northeasterly direction apparently about 3 feet in diameter and two thousand feet high falling nearly perpendicular at a rapid rate.

The dense smoke in the wake of the flaming fire ball was referred to by the Albany and Moultrie witnesses as a luminous trail following the flaming ball. Col. Dorris, who was in the vicinity of Pitts speaks of the smoke as a zig-zag trail lingering for some minutes and assuming various shapes. These shapes were thought by some to be in the form of letters. Several persons in the immediate vicinity of the fall described the smoke as white or gray in color and in form of puffs and very dense.

The first sound heard was compared to that of thunder and to many it was the first warning that any unusual occurrence was taking place in the sky above. At Cordele, 15 miles west of Pitts, the sound resembled that of a heavy explosion distinctly heard by several people on the streets. In the country four miles east of Cordele two terrific explosions were noted louder than thunder which so terrified the farm hands that they ran frightened to their homes. At Hawkinsville it was thought that an areoplane had exploded above the city. In the immediate vicinity of Pitts the sound was described as several loud explosions causing the earth to tremble, followed in quick succession by a number of lesser explosions.

The roaring and whizzing noise and the impact of the falling fragments were heard only in the immediate vicinity of the fall.

An explanation of the different phenomena above given are as follows: The rapidly moving fire ball was the meteorite itself made self

luminous by the friction produced in passing through the upper atmosphere. The high speed of meteorites when they first encounter the earth's atmosphere is said to be from 7 to 40 miles a second. The smoke is fused particles of the meteorite brushed off from its surface as it moves rapidly through the air. The sound compared to the booming of cannon and also the lesser sounds are supposed to be due to the explosion of the meteorite and the sudden heating of the surrounding air. The retardation of the meteorite by the resistance of the air exerts a powerful disruptive force upon it since the rear part of the meteorite tends to travel with planetary speed while the forward part is being checked. The whizzing and roaring noise heard some minutes after the loud explosion was produced by the fragments of the meteorite passing through the air. This sound was followed immediately by the impact of the falling fragments striking the ground.

DESCRIPTION OF INDIVIDUAL FRAGMENTS

The location and relative distribution of the points at which the fragments of the Pitts meteorite fell, are shown on the accompanying diagram.

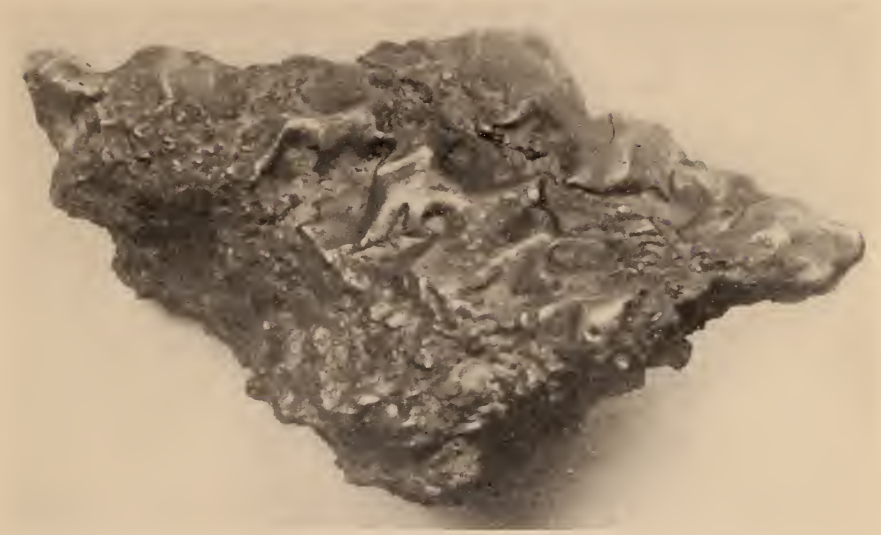
The largest piece weighing 57 ounces fell (see diagram) within less than 75 feet of Nancy Brinson's house where it was dug up a few minutes later still warm, but not red hot as first reported. The fragments entered the freshly plowed sandy soil to a depth of about 16 inches forming an inconspicuous hole less than 18 inches in diameter and scarcely half so deep. The fragment is irregular, rhomboidal in shape, the three greater dimensions being 5.7, 3.2, and 2.3 inches respectively. More than two-thirds of the surface shows the natural pitted characteristics of an iron meteorite coated with black iron oxide through which in places are to be seen patches of silvery white nickel iron. The remaining parts of the surface are rough and angular with more or less sharp projecting points showing evidence of recent rupture from other fragments. This surface is more or less smoked but it has not the thick coating of the other surface. The fragment is made up largely of nickel-iron throughout which, in irregular masses, occur the stoney material. The latter consists mainly of gray minerals interspersed with occasional greenish granules. Polished surfaces of the iron portions of the fragment when treated with dilute nitric acid show the typical markings of iron meteorites, known as Widmanstatten figures.

A second fragment fell by the roadside within a hundred feet of Jim Harden's house which is 700 feet southeast of the Brinson house

(see diagram). This specimen buried itself about 8 inches in the ground. It weighs 42½ ounces and differs from the fragment above described mainly in showing more stoney material and in being more irregular in shape. It also shows less of the naturally pitted surface but correspondingly more of the freshly fractured surface. This specimen is especially interesting as it fell within 3 feet of a negro boy who was walking along the road and as it furnishes data for reckoning the length of the time intervening between the first heavy explosions and the time which the fragments hit the ground. This time was reported by most persons who heard the meteorite strike the ground as about five minutes, but by timing the boy as he walked from the point at which he first heard the sound to the point where the meteorite struck the ground at his side, the time was found to be approximately 3 minutes.

The third fragment fell about 4000 feet southwest of the second fragment (see diagram) within 100 feet of where a negro man and boy were working in a cotton field. Only part of this specimen was seen as it had been cut in pieces. However, judging from the fragments it probably weighed less than 30 ounces. It entered the ground only about seven inches and like the other fragments was warm when dug up.

The fourth fragment was picked up in a public road approximately 5000 feet southwest of fragment No. 1 (see diagram). No one saw this fragment fall. Nevertheless it was at once recognized by the finder who had seen other fragments. This specimen is irregular. pear-shaped and weighs less than two ounces. The proportion of stoney material in this fragment seems to be greater than in any of the others but it is otherwise similar. This was the only fragment that did not bury itself in the ground which is accounted for by its falling on the hard road surface.



FRAGMENT OF PITTS METEORITE WHICH FELL NEAR JIM HADEN'S HOUSE (three-fourths natural size).

FRAGMENT OF PITTS METEORITE WHICH FELL NEAR NANCY BRINSON'S HOUSE (three-fourths natural size).

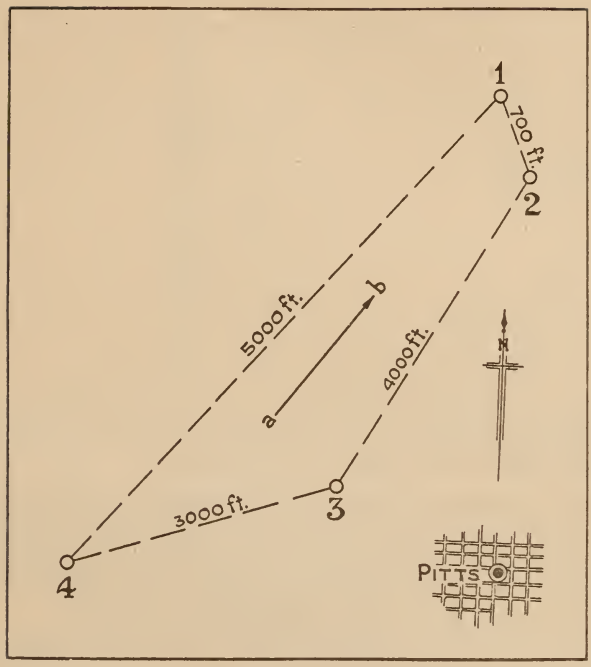


Diagram showing locations of the falls of the different fragments of the Pitts meteorite. 1. Nancy Brinson's house. 2. Jim Harden's house. 3. King's field. 4. Slater's house.

By examining the diagram, it will be seen that the four fragments which had been found at the time of my visit, were scattered over an area approximately a mile long and possibly a quarter of a mile wide. It will further be noted that the heavier fragments were found to the northeast of the area and the smaller fragments to the southeast. As the heavier fragments always travel at a greater distance than the smaller ones, this indicates that the meteorite was moving in a northeasterly direction, which fact was confirmed by several observers.

Mineral Composition

The composition of the meteorite, as shown by analysis made by Dr. Edgar Everhart, acting chemist, of the State Geological Survey is as follows:

Analysis of Pitts Meteorite

Constituents	Stoney Part	Metallic Part
Iron	.09	91.50
Nickel	.32	6.67
Tin	.20	.04
Copper	.00	trace
Silicon	.00	1.40
Sulphur	28.30	.02
Cobalt	trace	.45
Manganese	.00	.05
Manganese oxide	.27	
Soda	1.17	
Potash	.32	
Magnesia	5.96	
Alumina	.30	
Ferrous oxide	65.52	
Phosphorous pentoxide	.07	
Silica	8.46	
Carbon by difference	2.32	

Reckoning the sulphur and iron as pyrrhotite (FeS) the stony material contained 77.62 per cent of pyrrhotite, the rest, omitting carbon, corresponding most nearly to hypersthene.

Dr. George P. Merrill, of the National Museum, who made an examination of the stony part of one of the fragments, advised me that by optical and chemical methods he was able to make out the following minerals: olivine, diopside, and a plagioclase feldspar.

Fully 90 per cent of the four fragments was metallic, specific gravity, 7.23.

GENERAL STATEMENT REGARDING METEORITES

Dr. Oliver C. Farrington assigns the following three reasons for ascribing peculiar interest to the study of meteorites:

1. They are the only tangible source of knowledge regarding the universe beyond us.

2. They are portions of extra terrestial bodies.

3. They are a part of the economy of nature. No survey of nature can be considered complete which does not include an account of them.

Meteorites are a mass of mineral matter which come from space to the earth. The masses may be divided into two classes—stone and iron meteorites, and also an intermediate class which has been termed iron-stone meteorites. They range in size from a few grains to many tons and their fall is usually accompanied by peculiar phenomena, both of sound and light. Prior to the 18th century, the fall of meteorites was not accredited by scientists although numerous in-

stances were recorded. Plutarch tells of the fall of a stone in Thrace 470 B. C. Another meteorite is said to have been worshipped in Phrygia as the mother of the gods. The oldest meteorite in existence whose fall was observed is that which fell in Ensisheim on the 10th of November, 1492. This stone weighed 260 pounds and is still to be seen in the Rathhaus of the town. Since the beginning of the 18th century systematic steps have been taken for the study and preservation of meteorites. Records of numerous falls in European countries furnish the most interesting reading—the British museum of National History alone having specimens belonging to 566 distinct falls, 325 of which were actually observed. The largest collection in the world, however, is owned by the Field Museum, Chicago.

In this country, the meteorite which fell in the vicinity of Weston, Conn., at 6:30 p. m. December 26, 1807, is likely the first recorded fall. Especial interest is attached to this fall because the public at the time doubted the accuracy of the observers, the general opinion being that it was easier to believe that those who observed the phenomena lied than to believe that stones would fall from heaven. Evidence since that time, however, has left little doubt that the historians of the fall were describing what they really saw.

The most spectacular and terrifying meteorite fall recorded in this country is that of Homestead, Iowa. This fall took place February 12, 1875, about 10 p. m. Observers noted a meteor so bright that the naked eye could hardly bear the light. This light was not steady but sparkled like the twinklings of a huge fixed star, with now and then, lightning-like flashes. Those who stood near the line of flight were overcome with fear, as the size and motion of the meteor seemed to increase until it reached a point overhead when the meteor seemed to start suddenly and then looked as if it would come down upon them. Even the animals showed signs of alarm when the meteor threw down sparks, while deafening explosions, followed by rumbling crashing sounds rent the air. The volume of sound was so great that it seemed to shake the earth, many in fact believing that an earthquake was in progress.

Although the origin of meteorites is probably the most interesting subject connected with them, very little information of a satisfactory nature can be given concerning their genesis. The following theories as to their origin are taken from "Geology" by Chamberlin and Salisbury:

1. As matter projected from the earth by volcanoes and brought back to it.

2. As matter discharged from the moon.
3. As matter ejected from the sun or stars.
4. As dispersed matter from exploded stars.
5. As dispersed matter from exploded planets or satellites.
6. As the residue of scattered comets.
7. As fragments of tidally disrupted atmosphereless bodies, such as asteroids and satellites.
8. As accretions of age or fine particles of matter in open space.

All but the last pre-supposes the existence of the present solar system.

The most generally accepted theory is that meteorites are dispersed matter from shattered planets or satellites, although more study is needed before a satisfactory decision as to their origin can be reached.

May and June seem to be the months in which the greatest number of meteorites fall. Fifteen to twenty millions are said to fall daily, but comparatively few are of sufficient size to be seen by the naked eye. It is also said that the falls are much more numerous at some hours than at others, the greatest number falling from noon to 6 p. m.

There is no authentic record of any one's having been killed by a falling meteorite. The most narrow escape on record is that of three children in Braunan in 1847, when an iron meteorite weighing 40 pounds fell into the room where they were sleeping and covered them with debris, but did not seriously injure them. There have, however, been instances where animals are said to have been struck by falling stones and in one instance a dog was killed.

The largest individual meteorite known was brought by Lieutenant Perry from western Greenland to New York in 1895 and weighs 36½ tons. From this huge specimen, meteorites range in size all the way down to material of minute dimensions. Some meteoric showers produce large numbers of small stones, others only large ones. In form the most common shape is the cone, or conoid, which may be regarded as typical. Other shapes are shield-shaped, shell-shaped, bell-shaped, pear-shaped, column-shaped, ring-shaped, and jaw-shaped. These forms depend on the amount of shaping the meteorite undergoes while passing through the earth's atmosphere.

All meteorites when found are completely covered with a thin crust the result of their having been heated by passing through the atmosphere. The color of the crust varies with the composition of the meteorite, those having iron being black or dark-colored while in the case of the iron compounds being lacking, the crust may be nearly colorless.

As stated before, there are two general classes of meteorites, the stone and the iron with an intermediate class. In the first class the composition of material consists almost entirely of stony matter. Many specimens of this class have been seen to fall. In the second class the composition is mainly of metallic iron alloyed with nickel. Few of these have been seen to fall and in the intermediate class, meteors whose composition contains both stone and iron, to which the Pitts meteorite belongs, more have been seen to fall.

The absence of organic matter in meteorites, although they are supposed to come from some shattered planet, brings us no evidence that these planets have ever had life of any kind upon them.

The information in the above general statement regarding meteorites was taken largely from the work on meteorites of Dr. Farrington, of Field's Museum, and of Prof. Chamberlin, Chicago University, and from other sources.

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